INSTITUTE FOR DEFENSE ANALYSES

Assessing the Effect of Title 32 Active Guard and Reserves on Personal Readiness in the Army National Guard

Julie Pechacek, Project Leader
Allen Wang
Ethan Novak

September 2016
Approved for public release;
distribution is unlimited.
IDA Paper P-8123
Log: H 16-000962

INSTITUTE FOR DEFENSE ANALYSES
4850 Mark Center Drive
Alexandria, Virginia 22311-1882

About This Publication
The work was conducted by the Institute for Defense Analyses (IDA) under contract HQ0034-14-D-0001, Project DZ-6-3991, "Assessing the Impact of Full-Time Support on ARNG Readiness," for the Chief of the Army National Guard and the Chief of the National Guard Bureau. The views, opinions, and findings should not be construed as representing the official position of either the Department of Defense or the sponsoring organization.

Acknowledgments
The authors thank David Tate, Stanley Horowitz, and David Graham for their technical review of this document.

INSTITUTE FOR DEFENSE ANALYSES

IDA Paper P-8123

Assessing the Effect of Title 32 Active Guard and Reserves on Personal Readiness in the Army National Guard

Julie Pechacek, Project Leader
Allen Wang
Ethan Novak

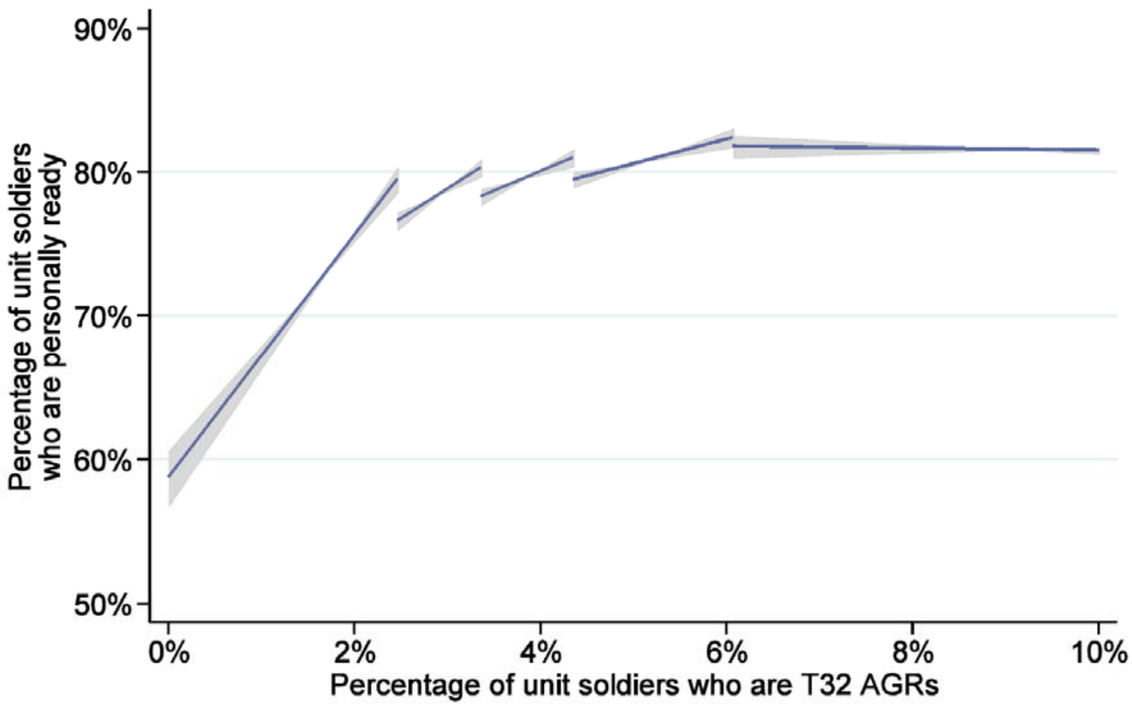
This page is intentionally blank.

Executive Summary

This research estimates the impact of Title 32 Active Guard Reserve soldiers (T32 AGRs) in the Army National Guard (ARNG) on the personal readiness of drilling soldiers located in approximately the same battalion-level unit. The analyses focus on Modified Table of Organization and Equipment (MTOE) units during "foundational readiness" periods, when individuals and units are not mobilized in preparation for deployment, deployed, or recently returned from deployment. Soldiers are considered "personally ready" in a given month if they are available to deploy in that month.

Movement of troops between units is correlated with T32 AGR exposure levels and personal readiness outcomes over the period of analysis, which confounds the unit-level relationship between personal readiness and T32 AGR staffing by introducing selection bias. Reorganizations and other common managerial practices (such as unit renaming and individual augmentee deployments) also muddle the analytic environment. These complexities prevent unit-level approaches from isolating the actual effect of T32 AGRs on personal readiness levels. The Institute for Defense Analyses (IDA) study team therefore developed an individual-level approach using 43 million monthly observations of ARNG members in MTOE units from 2001-2014. We calculate each individual's cumulative T32 AGR exposure separately, and allow individuals to carry that investment with them as they move between units. We then estimate the impact of T32 AGR exposure on personal readiness levels, holding constant the effects of a wide variety of personal and unit characteristics. To our knowledge, this is the first study to quantitatively estimate the impact of T32 AGRs on the generation of foundational personal readiness at the individual level.

We find that same-unit MTOE T32 AGRs have a persistent, robust, positive effect on personal readiness levels that diminishes as the ratio of T32 AGRs to total unit soldiers increases. The main results imply that for units with T32 AGR ratios in the lowest 20%, an increase of one percentage point in T32 AGR exposure increases the unit's ratio of personally ready drilling soldiers by 8.4 percentage points after adjusting for individual and unit characteristics. The next 20% of units average a marginal increase of 4.1 percentage points in the personally ready ratio following a one percentage point increase in T32 AGR exposures. This pattern of positive, decreasing returns continues, with the top 20% showing no statistically significant marginal impact on the personal readiness of the unit's drilling soldiers. This finding is unsurprising, given that the top 20% contains the largest share of headquarters units, which likely use T32 AGRs to achieve performance metrics other than the readiness of their own soldiers. The figure below shows the increase in readiness for additional T32 AGRs, estimated over five equal-sized blocks of units sorted by percent T32 AGRs in the unit.



Notes: 95% confidence bounds in gray.

Effect of T32 AGRs on Personal Readiness, by Quintile

We performed three excursions from the overall analysis: (1) excluding units with extremely low headcounts; (2) restricting the analysis to only combat arms units; and (3) restricting the analysis to only units unlikely to receive support from a TDA[1] troop command. In each of these cases, the estimated T32 AGR influence on personal readiness is greater than the overall estimate for all units.

Given the distribution of T32 AGRs and drilling soldiers as of September 2014, our results imply that a cut of 3,000 T32 AGRs (20%) distributed proportionately across all units would reduce the count of personally ready drilling soldiers by approximately 15,000 persons (5% of force). Conversely, an increase of 1,000 MTOE T32 AGRs focused in units with the lowest 20% current ratios of T32 AGRs and 500 MTOE T32 AGRs in the next 20% would increase the count of personally ready drilling soldiers by approximately 6,600 persons (2% of force).

Because we only assess the impact of T32 AGRs on personal readiness in their own units, our findings fail to capture any cross-unit returns that may exist, such as the impact of headquarters-level T32 AGRs on personal readiness in subordinate units or any influence of cross-leveled ready soldiers on their new units. We also consider only personal readiness, and do not examine medical readiness, equipment readiness, or other important metrics. For these reasons, our results should be interpreted as a lower-bound estimate of

---

[1] Table of Distribution and Allowances

the impact of T32 AGRs on readiness. While this work improves our understanding of the productivity outputs of T32 AGRs, determining optimal staffing levels would require analysis of their roles in producing equipment, unit, and other types of readiness, facilitation of non-readiness outcomes, and a detailed marginal cost assessment. Nonetheless, these results represent a first step toward identifying an efficient level of T32 AGR staffing at the battalion level.

Contents

1. Introduction

This research estimates the impact of Title 32 Active Guard Reserve soldiers (T32 AGRs) in the Army National Guard (ARNG) on achieving and maintaining the personal readiness of drilling soldiers present in the T32 AGRs' own unit. These analyses define personal readiness as a soldier's availability to deploy in a given month. As the elemental building block of an army, the stock of individually ready soldiers influences the time required to prepare ARNG units for deployment from their normal drilling state. This relationship is very important for military leaders to understand.

Wartime requirements and the resulting ARNG operational practices during the period of analysis from October 2001 to September 2014 complicate the assessment of T32 AGR influence on personal readiness. The practice of filling personnel gaps in deploying units with deployable soldiers from other units ("cross-leveling") underscores the importance of personal readiness generation and significantly complicates the analytic environment by introducing selection, thereby confounding the relationship between the personal readiness of a unit's soldiers and its staffing regimen. Table 1 shows that personal readiness, deployment, and T32 AGR exposure are each correlated with whether a soldier has moved between units at some point in his or her observed ARNG career.

Table 1. Personal Readiness, Deployment, and T32 Exposure by Unit Movement Status

	Fraction of months personally ready	T32 AGRs per 100 drilling soldiers in unit	Percentage of months deployed
Individual changes units	63.6%	4.6	8.1%
Individual does not change units	58.0%	4.2	4.1%

Significant unit reorganizations and an increase in small group and individual augmentee deployments also occurred during the analysis period. An innovative individual-level analytic approach is required to overcome measurement challenges stemming from the selective movement of individuals across units, and to assess the impact of T32 AGRs on personal readiness accurately. No unit-level analysis that ignores person-level variations in T32 AGR exposure and other characteristics can overcome this selection bias, or accurately assess the personal readiness productivity of AGRs.

The availability of an individual to deploy in a given month is a function of many factors. Physical ability and robustness, medical and dental evaluation, training status, dwell status, and administrative requirements (e.g., filing a legal will) all contribute to personal readiness.

This work examines personal readiness in units categorized under the Modified Table of Organization and Equipment (MTOE) during "foundational readiness" periods. Foundational readiness periods include time spans during which an individual has completed basic and primary skills training, and is not deployed, mobilized in preparation for deployment, or recovering from deployment. This framing facilitates the examination of personal readiness during periods when individuals are generally expected to be available for mobilization and deployment.

We find that same-unit T32 AGRs in MTOE units have a persistent, robust, and strongly positive effect on the personal readiness levels of drilling soldiers in their units. Quintile analysis reveals diminishing personal readiness returns to T32 AGR concentration as measured by the ratio of T32 AGRs to total soldiers within a battalion-level unit, as expected of any normal input to a production process. Model extensions excluding units with extremely low headcounts, restricting the analysis to only combat arms units, and restricting the analysis to only units unlikely to receive support from a TDA[2] troop command each result in larger estimates of T32 AGR influence on personal readiness. Because we assess the impact of T32 AGRs on personal readiness in their own units, our findings fail to capture any cross-unit returns that may exist, such as the potential influence of headquarters-level T32 AGRs on personal readiness in subordinate units. Our results should therefore be interpreted as lower bounds.

To our knowledge, this is the first study to quantitatively estimate the impact of T32 AGRs on the production of foundational individual readiness at the individual level. Previous studies are either qualitative—linking readiness and various types of full-time support (FTS) personnel based on anecdotal experience—or quantitative at the unit level, measuring the association between FTS and unit readiness over time. Interview-based studies on the relationship between FTS staffing and readiness include a 2000 report by the Government Accountability Office based on interviews with brigade combat team officials, finding that brigade commanders listed a shortage of FTS as a primary problem hindering the generation and maintenance of readiness. Using a similar methodology, a 2002 report by the Institute for Defense Analyses recommends increasing the number of FTS in units as one of the possible solutions to improving readiness levels.[3] Brauner and Gotz use a combination of unit readiness indicators and interviews to measure the impact

---

[2] Table of Distribution and Allowances.

[3] John E. Morrison, John Metzko, and Charles Hawkins, "Planning and Preparing for Training in Reserve Component Units," Alexandria, VA: Institute for Defense Analyses, April 2002.

of FTS staffing levels, and determine that increasing the number of FTS in deploying units is one solution for increasing readiness, given the administrative workload.[4] Finally, the Center for Army Analysis recently conducted a unit-level analysis of FTS and readiness and did not identify a relationship between FTS levels and unit p-ratings.[5] Given the readiness-related selection issues described above, it is unsurprising that unit-level analyses do not find a relationship between T32 AGRs and unit-level personal readiness.

This research considers only one of the many potential mechanisms by which T32 AGRs may influence readiness, and does not examine the other outcomes that T32 AGRs potentially influence. T32 AGRs have significant responsibilities beyond the production of personal readiness and outside the scope of this effort. While this work improves our understanding of the productivity outputs of T32 AGRs, determining optimal T32 staffing levels would additionally require a better understanding of:

- How T32 AGRs affect other kinds of readiness (such as unit-level readiness)
- How T32 AGRs facilitate non-readiness outcomes
- The costs associated with various T32 AGR staffing levels

---

[4] Marygail K. Brauner and Glenn A. Gotz, "Manning Full-Time Positions in Support of the Selected Reserve," Santa Monica: RAND Corporation, 1991. http://www.rand.org/content/dam/rand/pubs/reports/2007/R4034.pdf, accessed June 2016.

[5] Center for Army Analyses, "Full-Time Support and Readiness-Reserve Components (FAR-RC)," October 15, 2015.

2. Analytic Environment

A. Organizational context

1. Personnel in the Army National Guard

The ARNG consists of two primary groups of individuals. Drilling soldiers—the traditional guardsmen who make up the vast majority of the force—participate in 48 weekend drills and 15 training days annually, and are activated for mobilization or deployment to accommodate the needs of the state or federal governments. Full-time support (FTS) individuals are responsible for planning, training, administration, and maintenance, and include Active Guard and Reserve (AGR) personnel authorized under either Title 10 (T10) or T32 of the U.S. Code, Military Technicians (MilTechs), active component personnel, and federal civil servants.[6] This effort considers uniformed personnel only.

T10 AGRs are considered active duty under Title 10 of the U.S. Code, and are responsible for maintaining the operations of the ARNG at the national level. Title 10 U.S.C. §12310 defines the primary responsibilities of T10 AGRs as "organizing, administering, recruiting, instructing, or training the reserve components."[7] T10 AGRs are typically assigned to state and national headquarters positions.[8] In our data, 0.5% of records are attributed to T10 AGRs, only 4% of whom are assigned to MTOE units. The balance of the T10 AGR records reside in Table of Distribution and Allowances (TDA) headquarters units.[9]

T32 AGRs, like drilling soldiers, are subject to the authority of the governor of the state or territory in which they reside.[10] Like their Title 10 counterparts, T32 AGRs are responsible for "organizing, administering, recruiting, instructing, and training the reserve

---

[6] Marygail K. Brauner and Glenn A. Gotz, "Manning Full-Time Positions in Support of the Selected Reserve," Santa Monica: RAND Corporation, 1991. http://www.rand.org/content/dam/rand/pubs/reports/2007/R4034.pdf, accessed June 2016.

[7] These duties largely mirror those of the Secretary of the Army defined under Title 10 U.S. Code Sec. 3013.

[8] "General military law," Title 10 U.S. Code, Sec. 101, 2010 ed., https://goo.gl/5kyOfp, accessed June 2016.

[9] Explorative analysis did not reveal a relationship between statewide T10 AGR staffing levels and MTOE drilling soldier personal readiness rates observed at the unit level. This finding is unsurprising, given that T10 AGR duties do not typically involve unit-level efforts.

[10] "Active Guard and Reserve duty: governor's authority," Title 32 U.S. Code, Sec. 328, 2011 ed., https://goo.gl/4xfgup, accessed June 2016.

components."[11,12] They are assigned throughout the operational hierarchy to manage unit organization, administration, supplies, recruiting, training, personnel, and daily operations—duties that part-time drilling soldiers are generally unable to complete because of time constraints, or because the needed skills require development and maintenance.[13] T32 AGRs are funded through federal means administered at the state level. T32 AGRs are hypothesized to contribute to the generation and maintenance of personal readiness through their administrative and training roles (e.g., by obtaining and filing records used to determine the deployment eligibility), but the exact mechanism (if any) is unimportant in the context of this analysis. Although T32 AGRs may have distinct duty titles within a unit (such as "Supply NCO" or "Readiness NCO"), it appears that significant overlap between the T32 AGR sub-roles exists; not all T32 AGR roles are present in every unit. We will therefore assess the impact of each unit's total complement of T32 AGRs on the personal readiness outcomes of interest.

MilTechs are federal civilian employees who perform technical roles "in the organizing, administering, instructing, or training of the Selected Reserve or in the maintenance and repair of supplies or equipment."[14] In addition to their work as federal civilian employees, MilTechs also serve as drilling members of their civilian employment component. MilTech duties vary widely across units. Some actively assist T32 AGRs in unit management, while others remain exclusively focused on maintenance tasks, for example at repair facilities. The data provided for this effort associate MilTechs with their role as drilling soldiers, which in some cases equates to their civilian employment unit, but generally does not.

While T10 AGRs and MilTechs support the operations of the ARNG and its units, their organizational roles are not directly related to the production or maintenance of personal readiness. As a result, this work focuses on T32 AGRs.

2. T32 AGR staffing levels over the analysis period

Our data indicate that T32 AGR staffing levels increased over the analysis period. In 2002, prior to major ARNG participation in Operation Enduring Freedom (OEF), Operation Iraqi Freedom (OIF), and Operation New Dawn (OND), T32 AGRs comprised 5.03% of total man-months. At that time, Department of Defense (DOD) officials agreed

---

[11] These duties largely mirror those of the Secretary of the Army defined under 10 U.S.C. §3013.

[12] "Active Guard and Reserve duty: governor's authority," Title 32 U.S. Code, Sec. 328, 2011 ed., https://goo.gl/4xfgup, accessed June 2016.

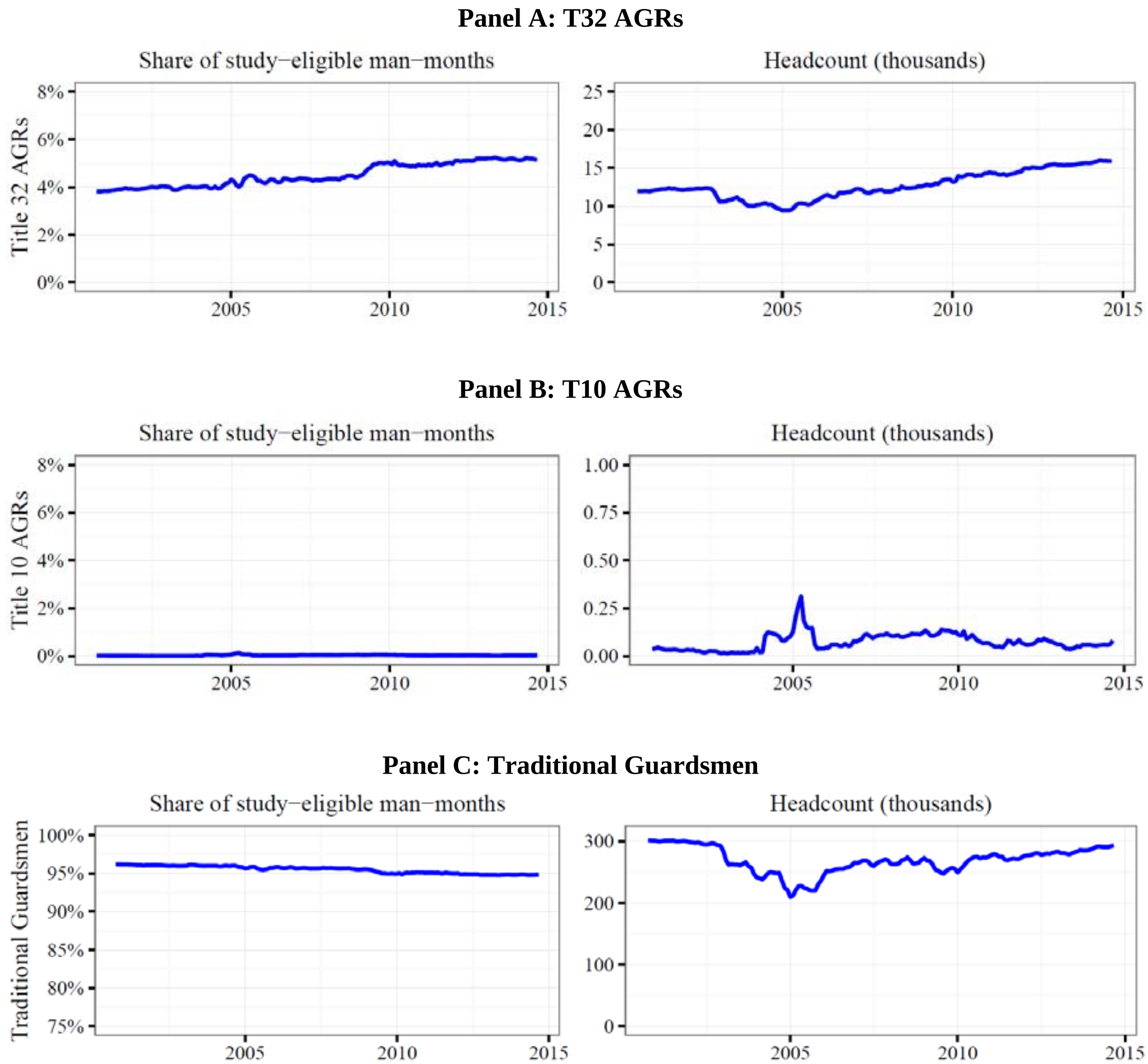
[13] Marygail K. Brauner and Glenn A. Gotz, "Manning Full-Time Positions in Support of the Selected Reserve," Santa Monica: RAND Corporation, 1991. http://www.rand.org/content/dam/rand/pubs/reports/2007/R4034.pdf, accessed June 2016.

[14] "Active Guard and Reserve duty: governor's authority," Title 32 U.S. Code, Sec. 709, 2011 ed., https://goo.gl/4xfgup, accessed June 2016.

that ARNG units did not have FTS adequate to maintain the required availability rates at the individual and unit levels.[15] As illustrated in Panel A of Figure 1 below, the share of non-deployed MTOE personnel who are T32 AGRs has increased gradually, to 6.57% of man-months by the end of the analysis period in September 2014. T32 AGR headcounts reached a local nadir in 2005 due to deployments for OEF and OIF. For reference, Panels B and C of Figure 1 present manpower shares and headcount levels for T10 AGRs and traditional guardsmen, respectively.

Debate over the appropriate levels of FTS in ARNG operational and headquarters units continues. Since the last data period available for these analyses, the project sponsor informed us that T32 AGR levels have decreased. If so, projections made using the September 2014 data may not accurately represent the present position of the ARNG along its personal readiness production curve. The context of the analysis period must be considered when assessing the implications of these analyses for the present force.

[15] John E. Morrison, John Metzko, and Charles Hawkins, "Planning and Preparing for Training in Reserve Component Units," Alexandria, VA: Institute for Defense Analyses, April 2002.



Note: Figures include individuals in MTOE units who are neither mobilized nor deployed. Panel C includes dual-status MilTechs as traditional guardsmen because they are observed as part of their drilling units.

Figure 1. Personnel Levels by Type Across Time

B. Determinants of personal readiness

Soldiers are considered "personally ready" in a given month if they meet deployment requirements in that month. These requirements primarily address soldiers' physical condition, military occupation specialty (MOS) qualification status, training status, and position in the deployment cycle. Administrative efforts of T32 AGRs both within and external to a soldier's unit could potentially impact these elements, which determine the readiness and competence of the force.

To meet physical and medical availability requirements, soldiers must pass an annual health assessment and not display any disqualifying medical condition. In addition to

demonstrating an acceptable level of health and fitness, soldiers must also possess current immunizations and reasonable dental health.[16] These factors are aggregated by the ARNG into a binary variable denoting availability to deploy as determined by medical assessment. As demonstrated in Table 2, medically unavailable soldiers are always unavailable for deployment, but a status of medically available does not necessarily imply availability to deploy.

Table 2. Personal and Medical Readiness

	Personally Ready	Not Personally Ready
Medically Available	29,205,723	20,516,008
Medically Unavailable	-	2,846,032

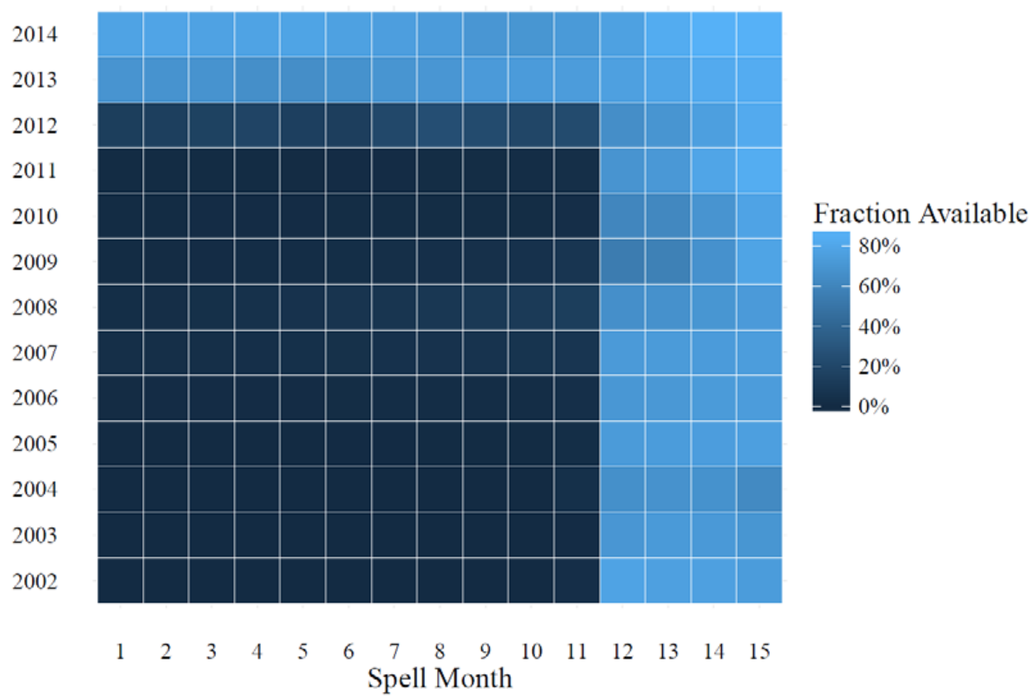
Cross-tabulation includes all man-month observations.

Soldiers must complete basic and primary skills training prior to deployment. We exclude individuals still in basic or initial entry training from analysis because T32 AGRs can influence neither availability nor the rates at which new recruits enter or complete their training during these periods.[17] MOS qualification signifies training beyond this elementary level and successful completion of an evaluation of an individual's ability to complete his or her duties.

An individual's dwell status also limits availability. Already mobilized or deployed individuals are considered unavailable. In addition, between 2001 and 2012 we observe limited availability of soldiers in the 12 months following deployment, as shown in Figure 2. (After 2010, we observe variety in availability rates, but the majority of recently deployed soldiers remain classified as unready. Our sponsors tell us that, after 2010, units could opt to allow individuals returning from deployment to choose when to re-enter the available pool; however, few units did so.) For this reason, we exclude all soldiers in the 11 months following a deployment from analysis.

[16] U.S. Army, "Standards of Medical Fitness," Washington, D.C.: Government Printing Office, 2007, ed. 2011.

[17] Basic and initial entry training timelines are driven by training availability. Recruiters are encouraged to coordinate the accession timing of new recruits accordingly.



Note: Includes individuals in MTOE units who are neither mobilized nor deployed.

Figure 2. Readiness by Year and Months Returned from Deployment

C. Unit structures and reorganizations over the analysis period

The ARNG mirrors the echelon structure of the active Army by organizing into divisions, brigades, battalions, and further partitions into smaller units. Divisions are the largest echelon and contain brigades, each made up of thousands of soldiers divided into battalions of several hundred soldiers. Unlike the active component, the ARNG is also organized by state or territory; funding for T32 AGRs is allocated separately within each state. Hence, even when larger entities within the hierarchy span multiple states, the investments made by T32 AGRs may remain concentrated within their respective states.

Units have specialized types corresponding to their primary purpose, described by a Standard Requirements Code (SRC), which distinguishes between infantry, aviation, medical, signal, military police, supply, engineering, and other categories. Auxiliary and support units, such as engineering and signal, deploy alongside combat units, such as infantry. Units with complementary roles are frequently combined into Brigade Combat Teams (BCTs) in order to create a modular deploying force. BCTs deploy as an entity combining multiple battalions. Some smaller ARNG units, however, deploy on their own to fulfill the needs of the active component.

Most units are supported at the battalion level and below by a complement of T32 AGRs located within the battalion and its subordinate elements. However, we observe in

the provided data that many non-combat unit types—such as medical, engineering, and signal—receive FTS support from TDA troop commands, which typically support several of these "commonly orphaned units." As a result, these unit types have a lower proportion of T32 AGRs located within the unit (3.8% T32 AGRs) than typical MTOE units (4.7% T32 AGRs). Unfortunately, the data do not allow identification of these troop command support relationships. To allow for this, we estimate our results both including and excluding commonly orphaned units.

To increase its effectiveness, the Army reorganized its units during the analysis period. Feickert reports that in 2005 the ARNG was eliminating, combining, and creating units.[18] Reorganizations sought to create a structure that improves readiness and modularity of the force. These efforts affect the hierarchy and our ability to track units over time through unit identifiers by changing these identifiers or modifying the support structure of a unit.

D. Cross-leveling and other troop movement between units

Although all individuals in the ARNG reside in a specific unit within the hierarchy at any given time, unit assignments are not permanent. We observe 1,948,019 Unit Identification Code (UIC) and 1,004,559 UIC-4[19] moves during the analysis period. To meet OEF/OIF/OND deployment demands, many deploying units relied upon transfers of soldiers from other units through a practice known as "cross-leveling."[20]

Cross-leveled soldiers join a deploying unit in the months immediately preceding mobilization, shortly after mobilization, or in mid-deployment as casualty replacements.[21,22] This practice allows receiving units to obtain an adequate complement of personally ready individuals (or individuals likely to be ready), fill key skill gaps, meet

[18] Andrew Feickert, "U.S. Army's Modular Redesign: Issues for Congress," U.S. Congressional Research Service, May 2006, http://fpc.state.gov/documents/organization/67816.pdf, accessed June 2016.

[19] UIC-4 is the UIC truncated at the fourth character, representing unit aggregation at approximately the parent unit level.

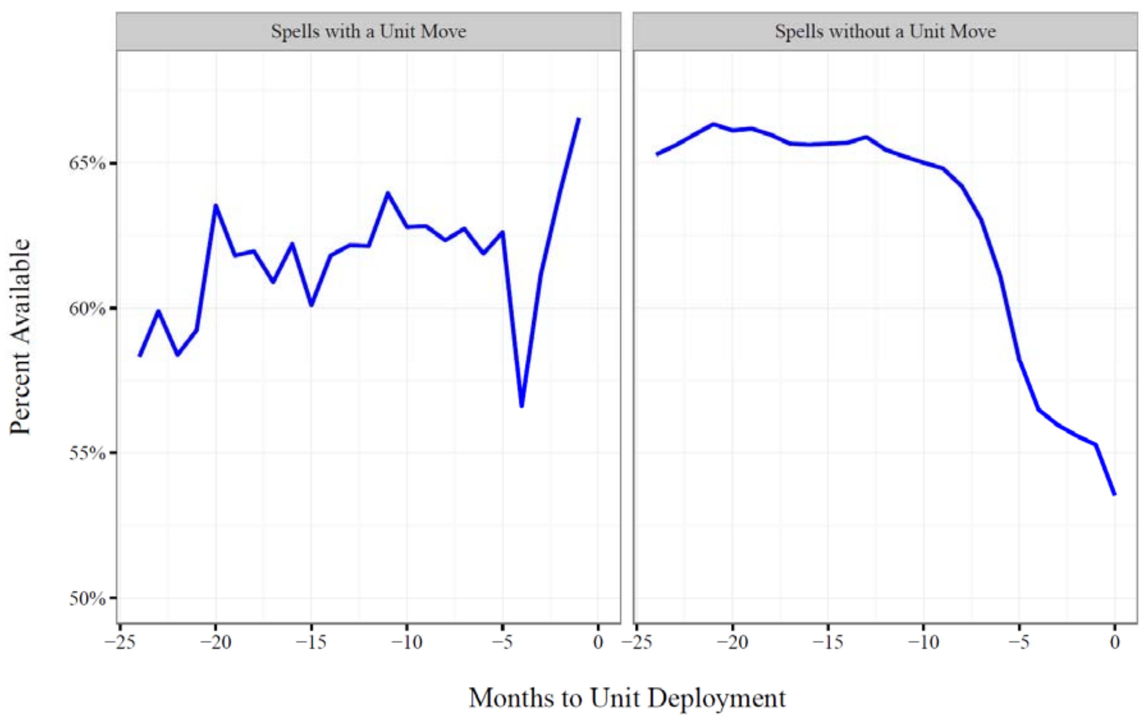
[20] Other possible reasons for unit reassignment include a soldier's physical relocation (moving house), promotion or other move into a new role, and unit reorganization.

[21] Michael J. Gilmore, "Issues That Affect the Readiness of the Army National Guard and Army Reserve. Testimony before the Commission on the National Guard and Reserves," Washington, D.C.: Congressional Budget Office, May 2007, https://goo.gl/7PzKyw, accessed June 2016.

[22] Like the other reserve components, the ARNG does not have a Trainee, Transient, Holdee, and Student (TTHS) account to manage readiness dynamically, as the active components do. Some ARNG units during the period of analysis were therefore authorized manpower in excess of identified requirements ("overstructured") to help them maintain 95 percent end strength; this practice was phased out by 2007. This mechanism may introduce opacity and complicate the identification of true end strength for affected periods and units. According to Gilmore, reorganizations meant to mitigate the effects of overstructuring have not eliminated the problem.

unit-level MOS qualification standards in time for deployment, and maintain required in-theater end strength without the use of a Trainee, Transient, Holdee, and Student (TTHS) account. Deploying ARNG units as late as 2007 possessed only 93 percent of the personnel they were expected to supply for a deployment.[23] Despite its prevalence, cross-leveling has unknown effects on the readiness and effectiveness of both cross-leveled individuals and the units receiving them; such unit movements could have positive effects if cross-unit skill transfers dominate, or negative effects if unit cohesion or effectiveness suffers following personnel churn. Simultaneously, soldiers who cannot be made ready in time for deployment are removed from deploying units into non-deploying units.

Figure 3 describes the readiness and deployment trajectories of individuals who move between battalion-level units in the months before that unit deploys. It supports the conclusion that different readiness processes may exist for those who move and those who do not.



Note: Figures include individuals in MTOE units who are neither mobilized nor deployed.

Figure 3. Readiness of Movers and Non-Movers Before Unit Deployment

If moves between units are non-randomly distributed across soldiers in a manner correlated with unit-level inputs (such as T32 AGRs), personal readiness, or unobservable

---

[23] Ibid.

factors influencing personal readiness, then selection bias will affect unit-level estimates of how these factors contribute to readiness. The selection bias problem will arise regardless of what motivates unit transfers. Both the nature of cross-leveling and the data indicate that such selection challenges exist in this environment. Therefore, any analysis unable to account for an individual's idiosyncratic readiness inputs (including T32 AGR exposures) and unobserved readiness factors cannot accurately assess the influence of unit-level readiness inputs. We therefore develop an innovative individual-level analytic approach to address these complexities.

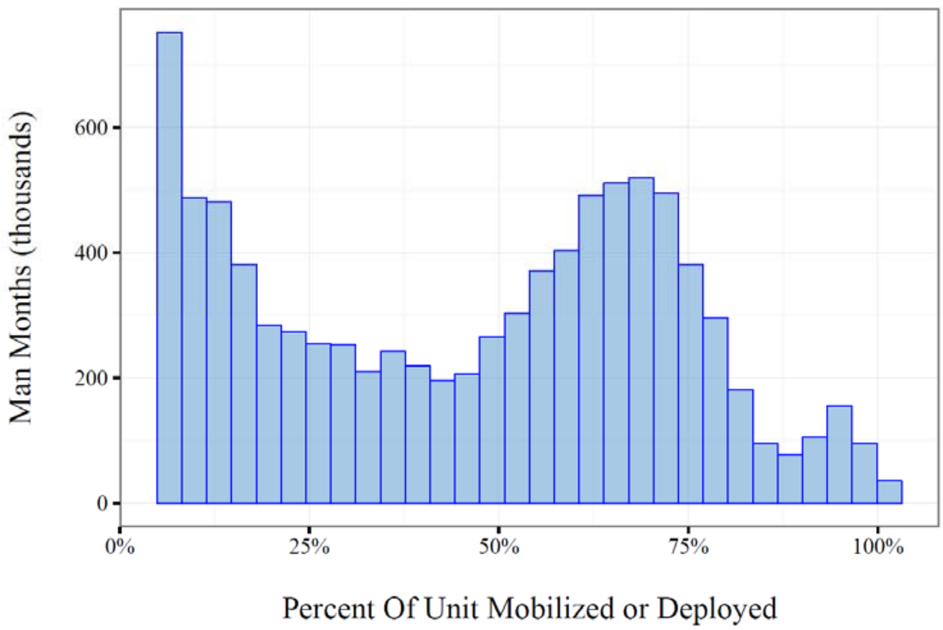
3. Data and Descriptive Statistics

A. Data overview

The ARNG Personnel Programs, Resources and Manpower Division (ARNG-HRM) Analysis Branch provided the data for these analyses, drawn from the ARNG G1 Lifecycle Data Warehouse. The raw data consist of 59 million man-month records for each of the approximately one million unique individuals who served in the ARNG from fiscal year 2001 to 2014 in all U.S. states and territories. Binary fields indicate soldiers' deployment availability, medical readiness, MOS qualification, mobilization status, and deployment status in each month. Additional fields include individual-level information on civilian and military education, gender, age, paygrade, physical health, duty restrictions, geographic location, training status, prior service status, and other human capital covariates. Unit-level covariates, including SRC, unit type (MTOE or TDA), unit name, and unit location, were also provided. In all, the raw data include 68 descriptive fields.

1. Identifying unit mobilization and deployment

Because unit readiness inputs change when units deploy, we must consider the case of those left behind by deploying cohorts. While individuals' deployment timing generally matches that of units, the prevalence of partial unit deployment demonstrates that this is not the case for a large fraction of units with any deployment in a given month. As shown in Figure 4, given that a positive fraction of a unit is deployed or in a mobilization leading to deployment, there are significant differences between units in how much of each unit is mobilized or deployed. In addition to cross-leveling, we observe substantial unit reorganization in the months preceding mobilization for deployment, as units consolidate non-deploying individuals into a common non-deploying unit (often a derivative UIC). Because readiness inputs to unit elements left behind when a battalion is predominantly deployed differ markedly from inputs received during typical foundational readiness periods, and the individuals left behind are more likely to be unready, retaining non-deploying units in the analysis would introduce a selection problem with ambiguous impact on the direction of the estimated coefficients. Because non-deploying individuals tend to be less ready than their deploying peers, leaving them in the analysis would artificially deflate our estimations of the effectiveness of the T32 AGRs that remain. On the other hand, if non-deploying T32 AGRs are reclassified as part-time drilling soldiers after a unit deploys (reducing the level of inputs), we will observe a spurious positive correlation between latent personal readiness levels remaining in the non-deploying unit related to a relatively low number of T32 AGRs.



Note: Histogram includes units wherein 5% or more of personnel are mobilized for deployment or deployed.

Figure 4. Share of Unit's Personnel Mobilized for Deployment or Deployed

To avoid contaminating the estimates in this manner, we exclude entire units from the analysis once they have deployed more than a threshold proportion of their total personnel. Sensitivity analysis over possible threshold proportions and comparison of the distribution of individuals' deployment lengths (in months) against the distribution of unit deployment lengths after applying the threshold led us to select a unit deployment threshold of 25%.[24] Using this threshold, match quality is high, as shown in Figure 5. Having flagged units as deployed in a given month using this threshold, we then remove that unit from the analysis for a period corresponding to the most common mobilization and deployment duration of its deploying members. This forms the first type of unit-level deployment exclusion in our analyses, and accounts for units that do not separate their non-deploying individuals into a differently named unit object from their deploying members. We exclude 3,370,419 man-month records (5.7%) from the main specification in this manner, as illustrated in Table 3, parts A and B.

[24] Sensitivity analysis was performed at the grouped SRC level to improve the fidelity of the deployment length distribution comparisons.

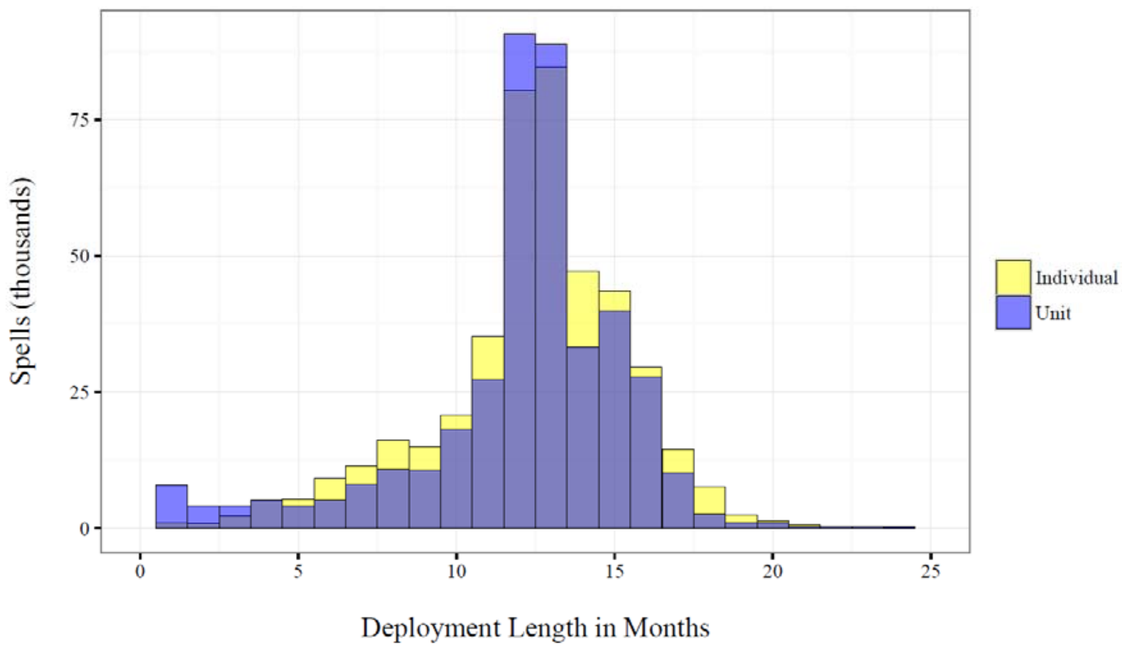


Figure 5. Individual v. Unit Deployment Lengths

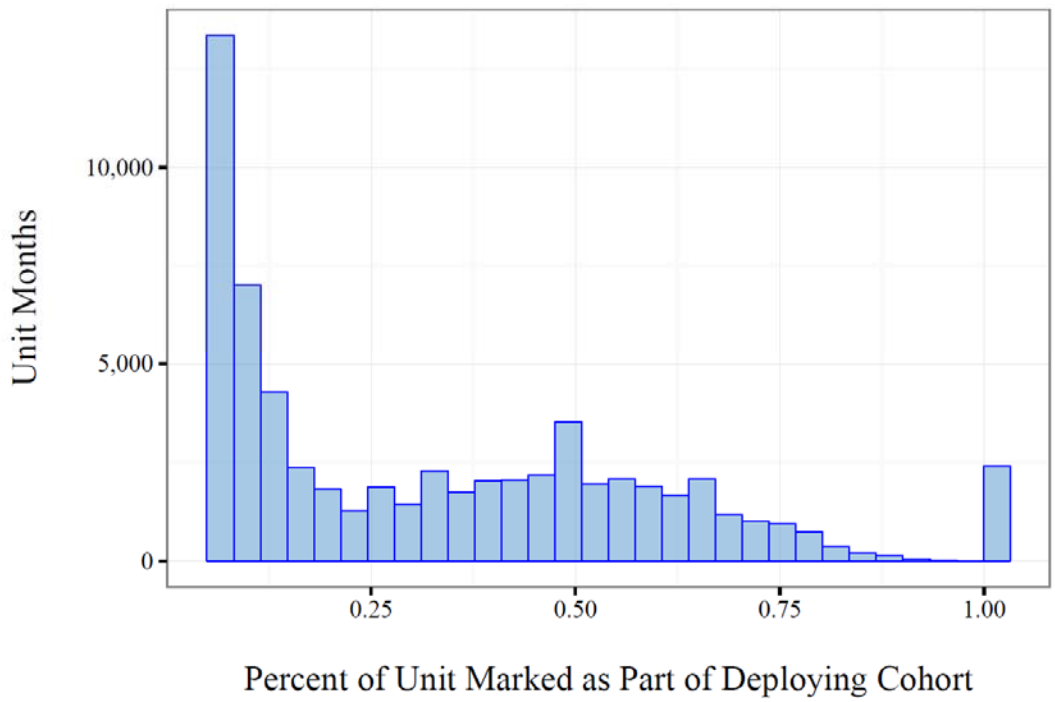
The second type of unit-level deployment exclusion we apply addresses situations in which units separate their non-deploying individuals into a differently named unit from their deploying members. For each individual in each month, we calculate the mean deployment status of the individual's present unit cohort 12 months in the future, and apply a 25% unit deployment threshold to the unit cohort, regardless of subsequent cross-leveling leading up to the deployment.[25] This allows us to identify individuals who are part of a unit cohort that will deploy, prior to any deployment-related reorganizations, and remove them from the analysis as if they had not been reorganized into a differently named non-deploying unit. Analogous to our treatment of left-behind individuals who are not relocated, we remove individuals identified in this manner for a period equal to the most common mobilization and deployment duration in their stable unit cohort in the main specification.[26]

The final type of unit-level deployment exclusion we apply addresses situations in which battalions concentrate their non-deploying members from several deploying unit sources into a single non-deploying unit. Such individuals are indeed left behind the

[25] Removal from the data is triggered when at least 25% of the unit deploys within a two-month period. This step is necessary, given the forward-looking nature of the stable unit cohort identification algorithm. A sizable number of unit deployments occur over a period of two months, and would otherwise not be captured.

[26] As a robustness check, we provide estimation specifications without this population cut in Table 9. No significant change in the coefficients occurs.

deploying group, but may not be identified by the first two methods, due to the timing of their joining the deploying unit—for example, if they entered after the stable unit cohort was established, or during the unit's deployment period. We identify such units by calculating the share of each unit's individuals who are flagged as part of a predominantly deployed stable unit cohort. A histogram illustrating the concentration of such non-deploying individuals across units is shown in Figure 6. In the main specification, we exclude 51,231 man-months (0.01%) for non-deploying soldiers in units wherein 50% or more of individuals are flagged as part of a predominantly deployed stable unit cohort.[27]



Note: Calculated on the unit-month level among non-deployed persons. Histogram displays fractions greater than 5% only for scaling purposes.

Figure 6. Shares of Units' Non-deployed Individuals Who Are Part of a Predominantly Deployed Stable Unit Cohort

[27] As a robustness check, we provide estimation specifications without this population cut in Table 9. No significant change in the coefficients occurs.

Table 3. Reconciling the Full Data to the Analysis Set

PART A

	Man-month records*	**MTOE units only**	**Excluding individuals who are mobilized for deployment or deployed**	**Excluding individuals in mobilized or deployed units**	**Excluding individuals in mobilized or deployed cohorts**
Total records in set	**59,080,618**	**52,567,763**	**47,325,117**	**44,055,342**	**43,430,235**
Share of all records in set	**100.00%**	**88.98%**	**80.10%**	**74.57%**	**73.51%**
Unique individuals	1,070,304	1,028,665	1,028,524	1,022,539	1,022,354
Share of individuals	100.00%	96.11%	96.10%	95.54%	95.52%
Unique units	5,631	4,424	4,367	4,353	4,331
Share of units	100.00%	78.57%	77.55%	77.30%	76.91%
T32 characteristics					
Total T32 count	3,188,313	2,161,381	2,130,256	2,022,880	1,987,030
Avg T32 count in unit	13	14	15	16	16
T32 share in unit	4.45%	4.44%	4.44%	4.52%	4.52%
Availability					
% Available	57.40%	55.56%	61.71%	62.85%	62.92%
% Medically unavailable	5.81%	5.41%	5.71%	5.47%	5.43%
% Otherwise unavailable	27.58%	29.08%	21.22%	20.62%	20.57%
% MOSQ	91.56%	90.95%	90.01%	90.42%	90.42%

*Column 1 excludes GMD & civil support units.

Table 3. Reconciling the Full Data to the Analysis Set (continued)

PART B

	Excluding individuals in mobilized or deployed cohorts	Excluding first 12 months following deployment	Excluding individuals in initial entry training	Analysis set
Total records in set	**43,430,235**	**39,674,168**	**33,636,667**	**32,988,586**
Share of all records in set	**73.51%**	**67.15%**	**56.93%**	**55.84%**
Unique individuals	1,022,354	1,021,162	865,062	862,602
Share of individuals	95.52%	95.41%	80.82%	80.59%
Unique units	4,331	4,258	4,185	4,075
Share of units	76.91%	75.62%	74.32%	72.37%
T32 characteristics				
Total T32 count	1,987,030	1,807,310	1,792,078	1,754,937
Avg T32 count in unit	16	16	16	16
T32 share in unit	4.52%	4.57%	4.61%	4.61%
Availability				
% Available	62.92%	67.42%	79.52%	79.60%
% Medically unavailable	5.43%	5.57%	6.11%	6.08%
% Otherwise unavailable	20.57%	14.65%	13.98%	13.91%
% MOSQ	90.42%	89.55%	97.87%	97.88%

2. Defining the set of study-eligible records

As described above, this work examines the personal readiness of individuals assigned to MTOE units during foundational readiness periods. We therefore exclude records for individuals in the following circumstances:

- Assigned to a permanently mobilized unit type[28]
- Assigned to a TDA unit[29]
- Deployed, or mobilized in a period immediately before or after deployment
- Part of a deployed unit cohort
- In the 12 months following a deployment[30]
- Incomplete initial entry training
- Aged younger than 18 or older than 60[31]
- Data missing in key fields[32]

These restrictions result in a study-eligible set of approximately 33 million man-month records relevant to the environment in which the hypothesized influence of T32 personnel on production or maintenance of personal readiness could take place. Table 3 parts A and B describe the evolution of the data from the raw set to the analysis set.

When excluding records associated with TDA units, the first two columns of Table 3 part A reveal that T32 AGRs are lost disproportionately. This disparity results because T32 AGRs make up a high fraction of TDA unit personnel (15%), where they serve in joint force headquarters or other administrative units overseeing ARNG operations. We observe

---

[28] Permanently mobilized units include ground-based missile defense units (28,445 records excluded) and civil support/WMD units (150,935 records excluded). These units are almost entirely comprised of T32 AGRs.

[29] Early iterations of this work attempted to associate individuals in TDA units with drilling soldiers in MTOE units. However, accurate matching of TDA personnel to supported MTOE individuals was only possible at the state level, which was too coarse to provide meaningful insights.

[30] Individuals in the first 12 months following deployment are overwhelmingly classified as unavailable for deployment. See Figure 2, and earlier discussion.

[31] Individuals younger than 18 are ineligible for deployment, and are likely participating in a high school-based early entry program. The few individuals who are recorded as over age 60 likely represent data entry errors in the birthdate field. Fewer than 22k records fell outside these age bounds and were excluded.

[32] We exclude 626k records due to missing data (1% of total records). Of these, nearly all were missing unit type information derived from SRCs. A subset of these records was missing personal characteristics, such as military or civilian education, health or physical status, or T32 FTS exposure (due to lag structure).

a change in personal readiness between the second and third columns of Table 3 part A after excluding records for those who are mobilized for a deployment or deployed. This exclusion does not affect medical readiness rates or MOS qualification rates, but the percent of "other unreadiness" decreases because the data classify mobilized or deployed individuals as otherwise unready, and unavailable by definition. When excluding records for individuals who do not deploy when the rest of their unit does, we observe a slight increase in both availability and the ratio of T32 AGRs in the unit. The identification of these records is described in the section identifying unit mobilization and deployment above.

As illustrated in Table 3 part B, both personal readiness and T32 AGR ratios increase after excluding records for individuals in the first 12 months following deployment, and those in initial entry training. This also increases MOS qualification rates, as seen in the third column of Table 3 part B. Finally, we limit the analysis to individuals aged 18 to 60, and lose a small number of records due to missing data in key analysis fields, likely due to incomplete administrative data entry. As shown in the last column of Table 3 part B, the resulting analysis set contains 33 million records.

3. Unit type subpopulations of interest

Table 4 breaks down the analysis set into four groups of observations. The first two groups, in columns 2 and 3 of Table 4, illustrate the difference between records that fall in a period[33] wherein an individual moves units, compared with a period wherein no unit move occurs. Approximately 52% of records fall in a period with a unit move. We observe that individuals who experience a unit move are in slightly smaller units, with fewer T32 AGRs, but a higher ratio of T32 AGRs to drilling soldiers than experienced by non-movers. Movers are slightly less personally ready than non-movers, and are more likely to be medically unavailable for deployment.

In addition to results calculated using all records in the analysis set, we also analyze two unit subsets of the analysis set: one excluding commonly orphaned unit types from the analysis set, and one including combat arms units only. Excluding commonly orphaned unit types results in an increase in both the average number and the share of T32 AGRs assigned to a unit, relative to the full analysis set. Because we are not able to identify the full set of T32 AGRs supporting commonly orphaned unit types,[34] the increase in T32 AGR coverage when excluding them is expected. Column 5 of Table 4 shows that combat arms likewise contain a larger complement of T32 AGR individuals, but the share of T32 AGRs

[33] We define a "period" as a set of consecutive months in a non-deployed, non-mobilized state. This "home spell" concept is defined in detail in section 3B, "Defining the panel framework," below.

[34] T32 AGRs supporting these units frequently reside in TDA troop commands.

is lower in combat arms units than in the analysis set, as combat arms units are typically larger than other units.[35]

[35] The unadjusted correlation between T32 AGR exposure and unit size is -0.03. The unadjusted correlation between T32 AGR exposure and personal readiness is 0.07.

Table 4. Analysis Set and Subpopulations of Interest

	Analysis set	Records in periods with a unit move	Records in periods without a unit move	Units excluding those commonly orphaned	Combat arms units
Total records in set	**32,988,586**	**18,934,070**	**14,054,516**	**19,514,792**	**11,312,801**
Share of all records in set	**55.84%**	**32.05%**	**23.79%**	**33.03%**	**19.15%**
Unique individuals	862,602	446,338	534,920	602,389	389,058
Share of individuals	80.59%	41.70%	49.98%	56.28%	36.35%
Unique units	4,075	4,071	3,081	2,231	702
Share of units	72.37%	72.30%	54.71%	39.63%	12.47%
T32 characteristics					
Total T32 count	1,754,937	1,312,755	442,182	1,118,798	591,757
Avg T32 count in unit	16	15	17	22	21
T32 share in unit	4.61%	4.83%	4.31%	4.98%	4.51%
Availability					
% Available	79.60%	79.38%	79.90%	79.21%	77.53%
% Medically unavailable	6.08%	6.53%	5.47%	5.98%	5.54%
% Otherwise unavailable	13.91%	13.92%	13.89%	14.40%	16.63%
% MOSQ	97.88%	97.94%	97.80%	97.99%	98.31%

B. Defining the panel framework

The time-dependent character of FTS investments, the high level of time-based heterogeneity observed in the data, and the presence of unobserved variables for both individuals and units suggest a panel regression approach on both the individual and unit levels. Two timelines exist in this environment: that for individuals, who enter the ARNG, complete training, drill with units, mobilize, deploy, and return; and that for units, which receive investments of personnel and equipment, drill, conduct collective training, mobilize, deploy, and return. While these timelines often overlap, the data reveal significant diversity in the timing of individuals' critical events, even within units. For example, Figure 7 shows a large amount of variation in the number of months individuals spend in the ARNG in advance of deployment or between deployments. The experience at the unit level is also highly varied; for example, partial-unit deployment is a common occurrence, as illustrated by Figure 4, above. Resources are also unevenly distributed between units in correlation with unit features and unit deployment expectations. Finally, we must also account for the impact of calendar-based events, such as funding flows and time trends, which may also influence unit resourcing. Combined with the pervasive practice of cross-leveling, these complexities suggest consideration of both individuals' and units' timelines.

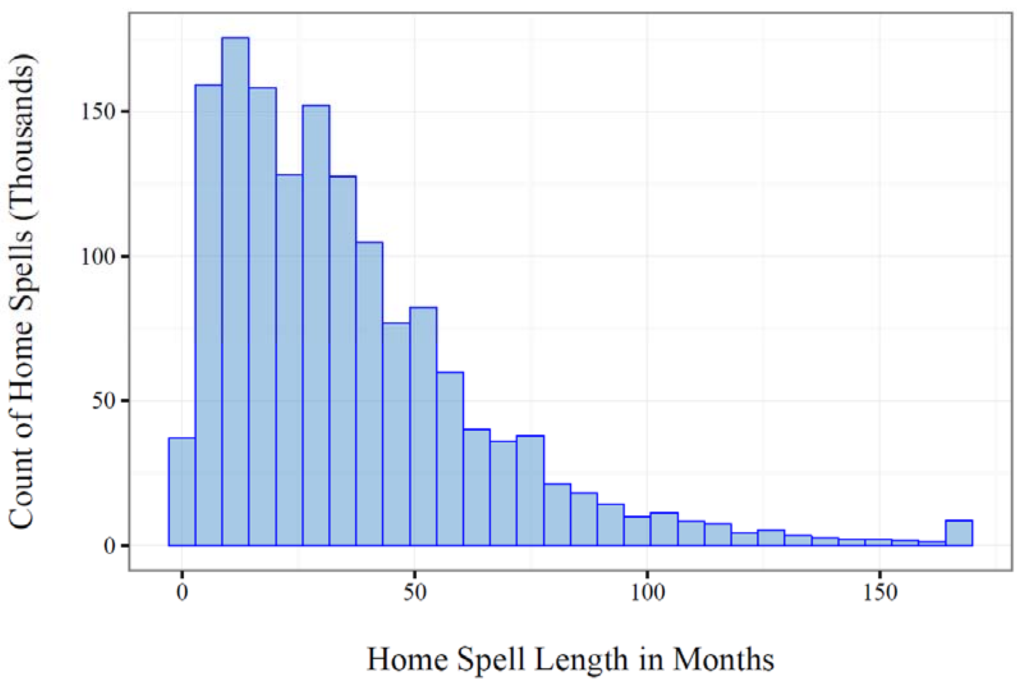


Figure 7. Months Spent in Unit Prior to Mobilization for Deployment

1. Individual-level "home spell" panels

We define individuals' timelines with respect to their mobilization and deployment cycles. Because deployment events "reset" an individual's readiness process, we break each individual's time series of records into separate "home spell" panels based on deployment events. As this analysis focuses on personal readiness during foundational periods only, we also exclude periods of mobilization contiguous with a deployment, as mobilizations in preparation for deployment trigger investment flows beyond those typical of foundational readiness periods.[36] A home spell begins when an individual either enters the ARNG for the first time, or is de-mobilized following a deployment event. A home spell ends when an individual is mobilized for deployment, as depicted in Figure 8, Timeline A. Mobilizations that do not result in a deployment, such as those resulting in off-ramping like that depicted in Figure 8, Timeline B, do not signal the end of a home spell; during such mobilizations, the time to deployment indicators continue to decrement with respect to the next full deployment.[37]

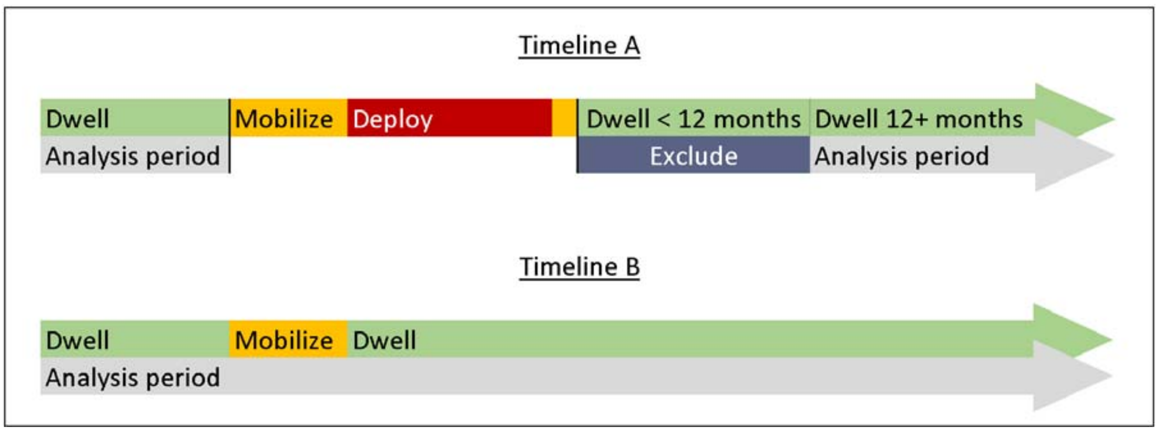


Figure 8. Example Individual Time Lines

[36] For example, use of Active Duty Operational Support (ADOS) individuals increases during mobilization periods in preparation for deployment. Such investment flows are beyond the scope of this analysis. Because the use of ADOS personnel and other atypical readiness investments may begin prior to unit mobilization, we tested the robustness of our findings by excluding the three months prior to mobilization from analysis. This exclusion strengthened the observed relationship between T32 AGRs and personal readiness, suggesting that the effect of the unobserved investment flows may introduce attenuation bias to the measurement of FTS impact in the months approaching mobilization for deployment.

[37] Mobilizations without deployment occur when a unit is mobilized for deployment and subsequently off-ramped because the unit is no longer needed for deployment. Activations for domestic operations frequently occur in support of natural disasters such as floods and hurricanes. For example, hurricanes Katrina (2005) and Sandy (2012) resulted in a high level of ARNG activation without deployment during the analysis period.

Individuals' panels are then formed on the person-by-home-spell level. As such, individuals remaining in the ARNG following their first deployment will be present in more than one panel. Because deploying likely changes an individual's underlying readiness attributes—for example, through learning or injuries—separation of each individual's home spells into separate panel events should improve the ability of the individual fixed effects estimates to capture home spell-invariant personal readiness features. To account for the pre-deployment increase in readiness resources expended on deploying individuals,[38] we define the time dimension in the individual-level panel analysis on months remaining until mobilization for deployment. This is accomplished by indicating whether an individual is at least two years from a mobilization resulting in deployment, between one and two years from such an event, or within each of the four quarters immediately preceding a mobilization for deployment. These indicators control for the time-varying changes in unobserved readiness inputs leading up to a deployment.

2. Unit-level panels

We define unit-level panels using calendar month and an aggregated unit identifier. Given the variation in unit staffing and organizational practices discussed in Part 2, identifying the appropriate level of unit aggregation proves somewhat complex. The ARNG is a multi-tiered organizational hierarchy, with T32 AGRs individuals located at each level. To estimate the efficacy of T32 AGRs in influencing personal readiness accurately, we must first associate them with the soldiers they support. Ideally, this would involve associating T32 AGRs at each relevant level of organizational hierarchy with their supported drilling soldiers, to assess how T32 AGRs at the various levels contribute to personal readiness. However, mapping units into complete organizational hierarchies is not possible, given inconsistencies in the assignment of UICs and the lack of a consistent and complete external hierarchy rubric following extensive unit reorganization.[39]

One approach would be to conduct the analysis at UIC level, which frequently corresponds to a company-sized unit. However, diversity in where organizations place headquarters structures complicates this approach: in some battalions, T32 AGRs are grouped into a battalion-level headquarters, while in others, T32 AGRs are allocated among the UICs they support. Gradations of this staffing pattern between these extremes also exist. To account for this variation and avoid contaminating the results with spurious correlations, we generate a new unit identifier to aggregate individuals to a level similar to

[38] For example, unobserved investments such as ADOS/ADSW personnel.

[39] C2 hierarchies describing unit command and support hierarchies are available beginning in 2011. Note also that position on the organizational hierarchy introduces diversity in the roles occupied by T32 AGRs.

a battalion. We refer to the resulting aggregated groups as a Battalion Approximations (BAs) hereafter. We then define regression panels using BA and calendar month.

To form BAs, we begin by grouping individuals based on the first four digits of the UIC to obtain a rough aggregation at the battalion level. This grouping imperfectly reflects the actual command hierarchy. Unit restructuring and the recycling of UICs across time complicate this grouping method by incorrectly combining personnel who do not share the same battalion, while excluding many who do belong together. We improve upon this basic aggregation by extracting brigade and battalion number and text signifiers from unit names, and continue to use the four-digit truncated UIC when adequate brigade and battalion information cannot be derived from the unit name. We then divide these groupings across state lines to reflect the state-based funding of T32 AGR positions.

As noted in Part 2 above, many records in the data are associated with military police, engineering, signal, quartermaster, medical, and other "commonly orphaned" unit types whose T32 AGR support often lies outside the traditional hierarchy of MTOE divisions, brigades, and battalions. Because the support relationship between an MTOE unit and a TDA troop command is impossible to identify in the data, our information on the FTS inputs provided to individuals in these units is incomplete. Combining individuals in commonly orphaned units with those in typical managed units would contaminate the identification of any relationship between T32 ARGs and readiness by introducing noise. As such, we aggregate individuals in orphan UICs separately from other components of the identified battalion structure, and provide regression specifications both including and excluding such BAs.

C. Features of individuals and units across the T32 AGR quintiles

After sorting units into quintiles based on their average T32 AGR exposure rates, we observe in Table 5 that individuals in first quintile units have lower readiness rates at 77.1 percent than those in the rest of the quintiles, of which at least 80 percent are personally ready. Given the high rates of "Otherwise unavailable" for the first quintile, this is likely due to individuals not being ready for administrative reasons.

Unit type accounts for several of the differences in unit composition. As seen in the sixth row of Table 5, the average size of units in the middle quintiles is larger than the average size in the first and fifth quintiles. Units in the middle quintiles tend to be combat arms units, which are larger than the commonly orphaned unit types and headquarters units that tend to occupy the first and fifth quintiles, respectively. Unit type also accounts for the relatively low percentages of women in the middle quintiles, since they are less likely to be members of a combat arms unit. Given that the fifth quintile consists primarily of headquarters units, it is not surprising that we find much higher percentages of officers, older average age, and higher levels of education in that quintile.

Table 5. Unit Characteristics by Title 32 Quintile

	Analysis set	Quintile 1	Quintile 2	Quintile 3	Quintile 4	Quintile 5
Analysis Set Characteristics						
% Individuals Available	81.5%	77.1%	81.5%	82.1%	83.0%	83.7%
% Not MOSQ	2.7%	2.7%	2.3%	2.3%	2.9%	3.1%
% Medically unavailable	5.1%	5.0%	4.8%	5.1%	5.2%	5.6%
% Otherwise unavailable	57.0%	62.7%	58.4%	54.4%	52.9%	50.1%
Min T32 %	0.0%	0.0%	2.5%	3.4%	4.4%	6.1%
Avg 6 mo T32 % exposure	4.5%	1.7%	2.9%	3.8%	5.1%	9.0%
Max T32 %	98.6%	2.5%	3.4%	4.4%	6.1%	98.6%
MTOE Battalion Approximation (BA) Characteristics						
Average number of soldiers in BA	361.2	276.0	376.4	446.7	439.7	282.3
Average T32 headcount in BA	15.6	5.0	11.1	17.1	22.5	22.5

Table continues on following page.

Table 5. Unit Characteristics by Title 32 Quintile (continued)

MTOE Battalion Approximation (BA) Characteristics, Continued						
	Analysis set	Quintile 1	Quintile 2	Quintile 3	Quintile 4	Quintile 5
Share of soldiers:						
In first spell	71.2%	72.9%	74.9%	72.1%	69.7%	65.3%
In reset after deployment	8.6%	13.0%	8.1%	7.6%	7.4%	7.0%
In initial entry training	13.9%	14.2%	14.8%	14.6%	14.0%	12.4%
AC to RC converts	8.1%	8.3%	8.4%	8.1%	7.9%	8.0%
Female	13.2%	15.2%	12.1%	10.1%	10.9%	17.6%
Less than high school	2.9%	3.3%	3.0%	2.9%	2.8%	2.3%
High school	74.6%	78.8%	78.8%	76.6%	73.9%	65.0%
Some college	12.8%	11.4%	11.3%	12.6%	13.1%	15.5%
Bachelor’s degree	8.2%	5.7%	6.0%	6.9%	8.7%	13.9%
Master’s degree or higher	1.5%	0.8%	0.8%	1.0%	1.4%	3.3%
Grades E1-E4	62.6%	69.2%	67.5%	65.0%	60.4%	50.9%
Grades E5-E9	31.7%	28.3%	29.4%	30.7%	33.3%	36.5%
Grades O1-O3	3.7%	1.9%	2.5%	3.3%	4.2%	6.9%
Grades O4-O9	1.0%	0.2%	0.2%	0.4%	0.9%	3.6%
Grades W	1.0%	0.5%	0.4%	0.6%	1.2%	2.1%
In HQ units	6.1%	1.6%	1.2%	1.2%	2.6%	23.5%
In medical units	2.4%	3.3%	2.9%	2.8%	1.6%	1.0%

Quintiles defined on unit T32 AGR-to-total soldiers ratio among all unit-month observations in the collapsed analysis set.

4. Estimation Methodology

We employ a two-step nested fixed effects linear regression strategy to estimate a human capital production function. In Step 1, we regress a binary indicator of personal readiness on a rich set of individual-level covariates. We use these estimates to develop a probability of being ready[40] for each individual in each month, given each persons' observed characteristics. In Step 2, we calculate each individual's T32 AGR exposure over various horizons. We then aggregate this and several other individual-level variables to the BA-by-month[41] level, including predicted personal readiness from Step 1, actual personal readiness, T32 AGR exposures, and other personal features. In Step 3, we regress each BA's observed ratio of personally ready drilling soldiers on the BA's average expected personal readiness, the T32 AGR exposures of the BA's drilling soldiers, and other BA-level attributes, to identify the effect of T32 AGR inputs on the BA's level of personal readiness.

A. Step 1: Individual-level panel regression

Step 1 estimates a fixed-effects linear probability model defined on an individual-by-home-spell period panel, as follows:

$$Ready_{im} = X_{im}\beta + T_{im}\gamma + FY_{im}\theta + c_i + \varepsilon_{im} \quad (1)$$

where $Ready_{im}$ is a binary variable indicating whether soldier i is personally ready[42] in home spell period m, X_{im} is a matrix containing individual characteristics, T_{im} is a matrix containing time to deployment indicators, FY_{im} is a set of fiscal year indicators, and c_i is a set of fixed effects indicators on the person-home-spell level.

Individual characteristics in X_{im} include age, age squared, soldier grade, civilian education, military education, medical readiness, physical ability, and unit type information derived from SRCs. Age and age squared are continuous variables, but the remaining individual characteristics are categorical in nature. Inclusion of these rich descriptors helps account for the uneven distribution of readiness-correlated demographic factors across units. Fixed effects indicators c_i absorb the remaining time-invariant individual heterogeneity within each home spell.

---

[40] Linear projection.

[41] BA stands for "Battalion Approximation." See Subsection 2B, "Unit-level panels," for the definition.

[42] An individual is considered personally ready if he or she is available for deployment in a given month, as determined by physical and medical requirements, completion of initial entry skills training, and position in the unit-level readiness cycle.

The indicators T_{im} denote the months remaining before mobilization for deployment, in 7 categories: 25 or more months until mobilization; 13 to 24 months until mobilization; 12 to 10 months until mobilization; 9 to 7 months until mobilization; 6 to 4 months until mobilization; 3 to 1 months until mobilization; and a truncation indicator for individuals present in the last observed month of the data whose spells do not end in mobilization or deployment.[43] Capturing an individual's time to mobilization for deployment allows comparison of soldiers across the unit-level readiness cycle, and accounts for unobserved variation in readiness inputs provided to soldiers preparing for deployment. The indicators FY_{im} account for the effects of readiness-related events fixed in calendar time.

Due to the high number of categorical variables in our Step 1 regression, certain specifications suffer from quasi-complete separation, or near-collinearity among case subsets of the estimation data. If unaddressed, quasi-complete separation prevents estimation of model parameters, as they are undefined within the separated subset; this can produce unbounded behavior in the estimates. Maximum likelihood methods, such as logit and probit regression, are particularly problematic and will not converge in this environment. Ordinary Least Squares estimation is well behaved, but results in larger numbers of dropped covariates than desired.

Two approaches exist for addressing quasi-complete separation: reducing the level of separation, or implementing bounded regression, which iterates over likelihood values and penalizes models with unbounded coefficients (for example, Firth logistic regression). Unfortunately, the behavior of Firth regression in the presence of fixed effects is not well understood. We therefore implement a linear probability model,[44] and reduce the severity of separation in the categorical variables by combining like categories to decrease the gradation in each. We group values in the fields describing soldier grade, education levels, physical ability, SRC codes, and time to mobilization for deployment into fewer categories, as described below. We combine soldiers' paygrades into five categories: enlisted ranks E1 through E4 and E5 through E9; officer ranks O1 through O3 and O4 through O10; and all warrant officer ranks together in one category. Education levels supply a proxy for ability, motivation, and other personal factors that contribute to personal readiness. We group civilian education into five categories consisting of less than high school education, high school diploma, some college, four-year degree, and graduate degree. We combine military education codes into 21 categories based on the first letter of the original alphanumeric codes, to differentiate course by type.

[43] Months to deployment were grouped to reduce quasi-separation in the Step 1 regression. Deeper discussion of this matter follows later in the methodology section.

[44] Readers will note that LPM can produce probability estimates outside the [0, 1] interval. Nevertheless, LPM is commonly used by economists to avoid the distributional assumptions made by logit and probit approaches to binary outcome analysis. The Step 1 predicted values on this data set are generally well behaved within the unit interval, with few outliers.

Medical readiness codes (MRCs) are unavailable in the data prior to 2008. To account for individuals' health status, we generate an indicator of poor health status using the time-consistent categories of physical capacity, upper body, lower body, hearing, ears, and psychiatric health (PULHES codes), which take on values between one (indicating no limitation) and four (indicating a severe limitation). Our indicator captures whether an individual has any of the PULHES codes at levels 3 or 4, as these scores denote a high likelihood of medical unavailability. We also group the 22 fields available in the "physical category" field into four supercategories, indicating whether an individual has no limitations, minor limitations (such as clothing restrictions or requiring hearing protection), physical limitations that impact activity and training ability, or deployment limitations (such as suffering a concussion or possessing a waiver excusing hazardous duty).

SRC codes indicate an individual's assigned unit type, which is correlated with training requirements, and may express selection by individuals into different unit types based on unobserved characteristics correlated with personal readiness status. We include indicators for SRC2 codes,[45] aggregated into deploying, auxiliary, administrative, aviation, and miscellaneous unit types. Combat arms and units comprise the deploying group, while units that frequently deploy to assist combat arms units form the auxiliary group (e.g., signal, supply, and engineering units). Administrative units include Joint Forces Headquarters, chaplain, or other supporting unit types. Information about the unit's location in the ARNG hierarchy is encoded in the fifth digit of the SRC codes.

B. Step 2: Calculation of T32 AGRs exposures and aggregations

In the second step, we complete numerous calculations to prepare for the unit-level analysis in Step 3. We first project the Step 1 estimates to form an expected personal readiness status for each individual in each month, given observed personal characteristics and person-by-home-spell fixed effects.

Also in the second step, we calculate each individual's T32 AGR exposure over various horizons, as

$$AGRratio_{imH} = \frac{1}{(H+1)} \sum_{h=0}^{H} \frac{T32AGR_{imh}}{Soldiers_{imh}} \qquad (2)$$

where $T32AGR_{imh}$ represents the number of T32 AGRs present in individual i's unit, $h = (0, \ldots, H)$ months prior to the current month m, and $Soldiers_{imh}$ represents the total number of drilling soldiers (T32 AGRs excluded) present in individual i's unit for each month. We calculate these uniformly weighted moving averages for 3-, 6-, and 12-month

[45] Aggregation by the first two characters of the SRC code; also known as TOE codes. These groupings can be found in Appendix B of the Structure and Manpower Allocation System (SAMAS) Code Book.

intervals. In addition, we also investigate the behavior of AGR exposure calculated using a 12-month ramp weighting, centered at four months.[46,47] The resulting $AGRratio_{imH}$ variables form the objects of greatest interest in the Step 3 unit-level regressions. We calculate AGR exposures over several horizons because the relevant timing structure of the impact of AGR inputs on personal readiness is unknown. We specify the variable of interest as a ratio of AGRs to drilling soldiers to account for unit size effects on the personal readiness productivity of T32 AGRs, as administrative tasks related to personal readiness are unlikely to involve positive returns to scale beyond the first few individuals. Due to the movement of individuals between units, not all persons within a unit will necessarily have identical T32 AGR exposures. Computing exposure rates on the individual level allows each individual to carry his or her unique T32 AGR inputs through unit transfers.

Finally in Step 2, we average actual personal readiness status (generating $UnitReady_{ut}$), projected personal readiness levels (generating $PredReady_{ut}$), AGR exposures $ARGratio_{imH}$ (generating $AGRexp_{ut}$), and personal characteristics (generating unit compositional variables) across unit personnel in each calendar month to form a set of unit-level regressors for use in Step 3. Unit compositional variables include shares of the unit's soldiers in each of the Step 1 paygrade categories and civilian education levels, the share who have never deployed, the share who have transitioned from active duty to the reserve component, and the share of women. We use the study-eligible set in calculating these unit compositional characteristics to account for spill-overs[48] that may occur in units where certain features are concentrated.[49] We account for the share of women, since personal readiness may differ based on this dimension due to unobservable unit-level factors correlated with the uptake of women in units.[50] In calculating the unit's percentage of actual personal readiness, mean projected personal readiness, and representative AGR

---

[46] Exact weights used in the 12-month ramp are 5, 10, 15, 25, 15, 10, 5, 5, 5, 3, 1, 1.

[47] These lag periods were chosen to cover a broad range of potential effective exposure horizons. It is possible that a different structure for lagged T32 AGR exposures would be more representative of the actual dynamic process of human capital accumulation. Further exploration may be warranted in this area, as the influence of T32 AGRs will be underestimated for any choice of weights different from the true relative influences of the lag periods, which is unknown and may vary by unit or individual characteristics.

[48] An example of a spill-over effect in this environment would be if units with more experienced personnel (as represented by a larger share of individuals in higher paygrades) achieve higher overall readiness because more experienced members provide informal guidance to less experienced members on the administrative steps necessary to achieve personal readiness. This is one among many possible spill-over mechanisms.

[49] The population for unit composition covariates includes all individuals in MTOE units who are not in a deployment status. It amends the Stage 1 prediction population by adding back left-truncated individuals, those waiting to complete initial entry training, those in the 12-month post-deployment dwell exclusion, and those with casewise-missing data elements.

[50] We find that the coefficient on share female is insignificant in the Step 3 unit-level regressions.

exposures, we average within units over individuals who have Step 1 personal readiness predictions (the prediction population), to avoid confounding the results of the Step 3 regressions with effects stemming from individual heterogeneity. These covariates enable us to account for the impact of inputs other than T32 AGRs on the generation and maintenance of personal readiness in the Step 3 estimation.[51]

Given the fact that associating T32 AGRs with their supported soldiers is more complex in some types of units than in others, we repeat this aggregation process for population subsets of particular interest: units excluding those that are commonly orphaned from their AGR support staff, and combat arms units. We form the subpopulation of commonly orphaned units based on the unit name text mining exercise described in Part 2 Section B2, and the subpopulation of combat arms units by aggregating units wherein the most frequent SRC indicates the unit is of infantry, armored, or artillery type (SRCs beginning in 06, 07, 17, 37, 44, 67, or 77).[52]

C. Step 3: Unit-level panel regression

In the third step, we investigate the impact of the average T32 AGR inputs received by unit members on the unit's average levels of personal readiness using a fixed effects linear regression defined on the unit-by-calendar month level. We estimate

$$UnitReady_{ut} = PredReady_{ut}\alpha + AGRexp_{ut}\beta + W_{ut}\varphi + FY_{ut}\omega + c_u + \varepsilon_{ut} \qquad (3)$$

where $UnitReady_{ut}$ is the ratio of drilling soldiers with Step 1 predictions who are personally ready in unit *u* in month *t*, $PredReady_{ut}$ is the mean of the expected personal readiness levels for drilling soldiers with Step 1 predictions, $AGRexp_{ut}$ is the mean of the *H*-month moving average T32 AGRs exposure ratios for drilling soldiers with Step 1 predictions, and W_{ut} is a matrix containing unit characteristics. As in Step 1, indicators for fiscal year in the matrix FY_{ut} account for time or budgetary impacts, and control for changes in policies or practices across time.

The $PredReady_{ut}$ term accounts for the level of personal readiness we would expect to observe in a particular month, given the unit's personnel complement. Inclusion of this covariate is critical, as the distribution of personal characteristics that impact

[51] One alternative to the unit-level aggregation would be to conduct the entire analysis on the individual level by pushing unit composition covariates and unit fixed effect indicators down to the individual level. However, as the Step 1 model already suffers from quasi-complete separation, additional indicator variable may destabilize the results. Such a model would also exceed our available computing capacity, despite utilizing 128G RAM. The nested regression solution renders the problem tractable, and still controls for the impact of unit-level factors on personal readiness.

[52] Because SRCs are assigned at the individual rather than the unit level, some inconsistency in SRCs exists within units.

personal readiness is very unlikely to be randomly distributed over units, and may be correlated with T32 AGR concentrations (for example by unit type or location).

In addition to the unit composition characteristics generated in Step 2 as described above, W_{ut} contains unit headcount quintile indicators to control for systematic differences in availability rates and unit-level resources between units of varying size. Including non-FTS related factors potentially contributing to the unit's level of personal readiness allows clean estimation of the relationship between personal readiness and T32 AGR levels.

Potential endogeneity as a result of unit types affecting T32 AGR allocation requires a fixed effects model. Aviation units, for example, receive much higher T32 AGR staffing levels than units of other types. Fixed effects model guards against comparing dissimilar units that would yield spurious relationships between absolute T32 AGR levels and readiness levels. Instead, the model compares readiness and T32 AGR staffing levels across time separately for each unit.

We estimate the model both on the Step 3 data set overall, and separately by quintiles defined on T32 AGR exposure levels.[53] Estimating separately for each quintile allows modeling of a readiness personal production function, by distinguishing between the impact of T32 AGR staffing perturbations at different levels of T32 AGR saturation. In addition to estimating separately on the populations in the quintiles defined on T32 AGRs staffing levels, we also produce estimates for units excluding commonly orphaned types, and for combat arms units, with populations as described above.

[53] Quintile calculation is weighted by unit headcounts.

5. Results and Discussion

A. Results for all unit types

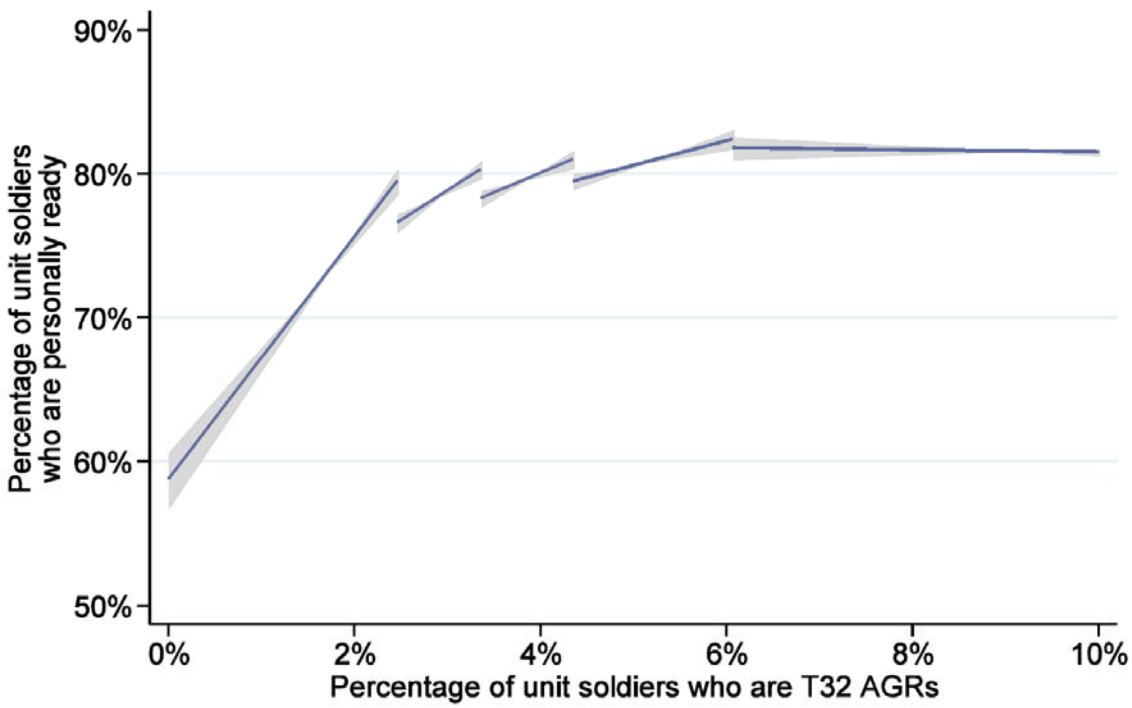
Table 6 displays unit-level regression coefficients (Equation 3) for six-month moving average T32 AGR exposure, for all BA types. Each coefficient results from a separate regression on the population indicated, and represents a linear slope estimate for the marginal personal readiness productivity of T32 AGRs over the saturation levels present in the data (see the descriptive statistics in the second portion of the table). Regressions in the first column present results estimated over levels of T32 AGR exposure pooled together. Columns 2 through 6 display coefficients resulting from partitioning T32 AGR saturation levels into quintiles, ranging from least exposure in Quintile 1 to highest exposure in Quintile 5.[54]

As demonstrated by the coefficients in the first row of Table 6, a positive and statistically significant relationship exists between drilling soldiers' T32 AGR exposure levels and their personal readiness. The quintile analyses reveal that T32 AGRs' relative efficacy in improving rates of same-BA personal readiness among drilling soldiers varies over their concentration in the BA, following a classic diminishing returns relationship. The coefficients for all observations imply that for BAs in the first quintile of T32 AGR saturation, an increase of one percentage point in T32 AGR exposures would increase the BA's ratio of personally ready drilling soldiers by 8.4 percentage points on average.[55] For example, in a first-quintile BA of 300 individuals (and assuming the median BA contains 300 members), three additional T32 AGRs (representing an increase of one percentage point in T32 AGR saturation) would result in the production of personal readiness in approximately 25 additional drilling soldiers. By contrast, these analyses imply that an equal-sized T32 AGR addition in a fifth quintile BA has no significant marginal impact on the personal readiness of the BA's drilling soldiers. This finding is expected given that the fifth quintile contains the largest share of headquarters units, which focus on readiness and other performance metrics for units other than their own. Taken together, the quintile coefficients approximate a personal readiness production function, adjusted for individual and BA characteristics, as depicted for each quintile's average BA in Figure 7.

[54] Calculation of T32 AGR saturation is described in Equation 2.

[55] Ordinary Least Squares (OLS) regression estimates, of which fixed effects estimation is a special case, represent a linear approximation of the relationship between an outcome and various factors over a range of input values for those factors. Each factor's impact estimate is most accurate near the center of the range of input values, which in this case is the median T32 AGR ratio within each quintile. The degree to which the underlying data generating process is linear in nature determines the reliability of these estimates at extreme input values within their range.

Despite controlling for relative BA size, it is possible that outlier BAs containing very few individuals may experience a different readiness process than BAs with many individuals, or may employ their T32 AGRs in atypical ways. In particular, many small BAs were formed over the period of analysis to accommodate the deployment of small groups of individuals. Another possibility is that headquarters BAs may be overrepresented among low headcount BAs, if such groups are coded separately from the drilling soldiers they support. The second row of Table 6 displays overall and quintile regression results for all BA types, excluding BAs with monthly headcounts at or below the fifth percentile.[56] We observe that the relationships identified for the complete analysis set (first row) are strengthened by the removal of BAs with very small headcounts, which supports the notion that such BAs have atypical personal readiness production experiences.



Note: 95% confidence bounds in gray.

Figure 9. Effect of T32 AGRs on Personal Readiness, by Quintile

B. T32 AGR exposure structure robustness checks and horizon exploration

Table 7 considers the impact of variations in the lagged T32 AGR exposure structure on the observed results. In addition to the 6-month moving average utilized in the main

---

[56] For the results presented in Table 6, the fifth percentile of unit headcount is equal to three individuals.

results discussed above, we consider 3- and 12-month moving averages (variations on Equation 2), as well as a 12-month ramping average.[57] Ideally, such analysis might inform optimal investment timing by identifying the horizon over which T32 AGRs have greatest impact. However, time limitations prevented us from fully exploring the entire space of how BAs with various T32 AGR levels might best prioritize or allocate workload. Furthermore, changes in the magnitude of the coefficients within each quintile suggest that unit type might matter in determining optimal exposure lengths.

The marginal productivity results are robust to various lag structures and display the same diminishing returns relationship previously noted. Compared with the baseline 6-month moving average results, the 3-month moving average in the first row of Table 7 displays higher coefficients in the first quintile, but lower coefficients across other subpopulations, suggesting that gains from increased T32 AGR levels are quickly realized in BAs that have had relatively low levels of investment historically. The 12-month moving average improves on the 6-month moving average for BAs in Quintiles 2, 3, and 4, suggesting that some unit types may require longer exposure periods in order for T32 AGRs to impact personal readiness. The 12-month ramp results lie somewhat in between those of the 6- and 12-month moving averages. Overall, these analyses suggest there may be considerable “ramp-up” time before an increased complement of T32 AGRs can impact personal readiness for certain BAs.

C. Robustness to unit mobilization and deployment drops

Table 8 illustrates the sensitivity of these findings to the population exclusions applied to account for BA cohort deployment. Compared with the base result presented in row one, which excludes those identified as part of a BA cohort that is predominantly mobilized or deployed (see detailed discussion in Part 3 Section A), variations on the BA cohort deployment exclusion criteria have essentially no impact on the magnitude or direction of the estimated coefficients. As noted previously, it is unclear *a priori* how the inclusion of these man-months will impact the estimated coefficients. However, against a reasonable concern that the exclusions involved in the main analysis might bias the results, Table 8 demonstrates that the results are quite robust to alternate treatments of BA mobilization for deployment. In particular, results in the last row of Table 8 are estimated without cohort deployment drops of any kind. No meaningful variation in the estimates is noted in comparison to the base result.

[57] Weights on individuals’ last 12 months of T32 AGR exposures, counting backward, are 5%, 10%, 15%, 25%, 15%, 10%, 5%, 5%, 5%, 3%, 1%, and 1%.

D. Results for select unit subsets

As noted in the exposition on common unit hierarchies above, certain unit types are commonly separated from the T32 AGRs supporting their BAs (see Part 2 Section C). These units include Engineering, Military Intelligence, Special Forces, Signal, Medical, Military Police, and Chemical. As we cannot distinguish those that are separated from their supporting T32 AGRs from those that are not, Table 9 presents the results of BA-level regression analysis excluding all units flagged as belonging to these "commonly orphaned" types. The observed coefficients largely resemble the shape and magnitude of the base results, with slightly higher estimates in the first and second quintiles.

Restricting the analysis to units in infantry, armored, and artillery units (SRC codes beginning in 06, 07, 17, 37, 44, 67, and 77), we find that the impact of T32 AGRs increases significantly in the first two quintiles compared to those for all BAs. The coefficients for all combat arms observations (third row of Table 9) imply that for an average combat unit in the first quintile of T32 AGR saturation, an increase of one percentage point in T32 AGR exposures would increase the BA's ratio of personally ready drilling soldiers by 11.6 percentage points. Thus, in a first-quintile BA of 300 individuals (and assuming the median BA contains 300 members), three additional T32 AGRs would result in an increase in personal readiness for approximately 35 additional drilling soldiers. Results in quintile 3 more closely resemble those for all BA types. Estimates in quintiles 4 and 5 are imprecise, but generally positive.

Table 6. All BAs Regression Results

Regression on six month moving average FTS	All Observations	Quintile 1	Quintile 2	Quintile 3	Quintile 4	Quintile 5
All observations	1.130***	8.435***	4.125***	2.732***	1.709***	-0.0703
	(7.268)	(14.627)	(6.049)	(4.661)	(5.012)	(-0.551)
Excluding small BAs	1.394***	8.867***	4.227***	2.697***	1.717***	0.127*
	(13.332)	(15.383)	(6.179)	(4.618)	(5.089)	(2.093)
BA Characteristics						
Avg. Num. Soldiers	361.2	274.8	375.3	446.2	438.8	281.2
Avg. T32 headcount	15.6	5.0	11.0	17.1	22.4	22.4
Min T32 %	0.0%	0.0%	2.5%	3.4%	4.4%	6.1%
Mean 6mo T32 exposure	4.5%	1.7%	2.9%	3.8%	5.1%	9.0%
Max T32 %	98.6%	2.5%	3.4%	4.4%	6.1%	98.6%
% HQ	6.1%	1.6%	1.2%	1.2%	2.7%	23.7%

Notes: Statistically significant at or above the *** 1% level, ** 5% level, * 10% level; t-statistics in parentheses. Each reported coefficient results from a separate regression (Estimation Step 2) within the indicated BA population and quintile. In addition to the fraction of each BA's soldiers in T32 AGR status, regressions include each BA's estimated personal readiness based on the assigned individuals' personal characteristics (linear projections from Estimation Step 1), proportional BA composition for soldier grade in 5 categories, civilian education in 4 categories, individuals who have never deployed, former active component soldiers, fiscal year, SRC type and category, UPC size quintile, and percent female.

Table 7. T32 AGR Lag Structure Regressions, All BA Types

Regression coefficients for T32 AGR exposure over various horizons	All Observations	Quintile 1	Quintile 2	Quintile 3	Quintile 4	Quintile 5
3-month moving average	1.076***	9.163***	3.143***	1.426**	1.250***	-0.157
	(8.392)	(17.560)	(4.951)	(2.594)	(3.841)	(-1.446)
6-month moving average	1.130***	8.435***	4.125***	2.732***	1.709***	-0.0703
	(7.268)	(14.627)	(6.049)	(4.661)	(5.012)	(-0.551)
12-month moving average	1.167***	7.032***	4.978***	4.647***	2.025***	0.00881
	(6.385)	(10.069)	(6.530)	(6.449)	(4.813)	(0.055)
12-month ramp moving average	1.096***	7.765***	4.164***	3.227***	1.907***	-0.0468
	(6.600)	(12.758)	(5.700)	(5.392)	(5.120)	(-0.358)

Notes: Statistically significant at or above the *** 0.1% level, ** 1% level, * 5% level; t-statistics in parentheses. Each reported coefficient results from a separate regression (Estimation Step 2) within the indicated T32 AGR lag structure and population. In addition to the fraction of each BA's soldiers in T32 AGR status, regressions include each BA's estimated personal readiness based on the assigned individuals' personal characteristics (linear projections from Estimation Step 1), proportional BA composition for soldier grade in 5 categories, civilian education in 4 categories, individuals who have never deployed, former active component soldiers, fiscal year, SRC type and category, UPC size quintile, and percent female. Moving averages calculated as equal-weighted lagged moving averages including current month, except for 12-month ramp weighting, which uses a 5, 10, 15, 25, 15, 10, 5, 5, 5, 3, 1, 1 weighting structure.

Table 8. BA Deployment Drop Robustness Checks, All BA Types

	All Observations	Quintile 1	Quintile 2	Quintile 3	Quintile 4	Quintile 5
Base specification, 6-month moving average T32 AGR exposure						
Base specification	1.130***	8.435***	4.125***	2.732***	1.709***	-0.0703
	(7.268)	(14.627)	(6.049)	(4.661)	(5.012)	(-0.551)
Sensitivity analyses, 6-month moving average T32 AGR exposure						
Exclude those whose native BA object deploys 25% or more	1.130***	8.435***	4.126***	2.733***	1.709***	-0.0702
	(7.262)	(14.630)	(6.050)	(4.662)	(5.011)	(-0.549)
Exclude those whose native BA object deploys 50% or more	1.129***	8.434***	4.118***	2.734***	1.712***	-0.0704
	(7.239)	(14.625)	(6.044)	(4.667)	(5.019)	(-0.549)
Exclude those without Step 1 predictions	1.127***	8.429***	4.109***	2.734***	1.712***	-0.0709
	(7.238)	(14.617)	(6.029)	(4.670)	(5.027)	(-0.553)

Notes: Statistically significant at or above the *** 0.1% level, ** 1% level, * 5% level; t-statistics in parentheses. Robustness specifications were calculated by changing the analysis population by the above specifications in the step 1 regression and propagating these changes through the rest of the steps of data processing and regressions.

Table 9. Results for select BA types

Regression coefficients for 6-month moving average T32 AGR exposure	All Observations	Quintile 1	Quintile 2	Quintile 3	Quintile 4	Quintile 5
Base results, all BA types	1.130***	8.435***	4.125***	2.732***	1.709***	-0.0703
	(7.268)	(14.627)	(6.049)	(4.661)	(5.012)	(-0.551)
BAs excluding commonly orphaned types	1.202***	8.638***	5.360***	2.779***	1.466***	-0.145
	(5.204)	(9.722)	(5.009)	(4.208)	(3.357)	(-0.862)
Combat arms BA types	1.656***	11.62***	7.276***	2.663*	1.593	-0.116
	(3.331)	(11.043)	(4.854)	(2.086)	(1.887)	(-0.362)

Notes: Statistically significant at or above the *** 0.1% level, ** 1% level, * 5% level; t-statistics in parentheses. Each reported coefficient results from a separate regression (Estimation Step 2) within the indicated BA population and quintile. In addition to the fraction of each BA's soldiers in T32 AGR status, regressions include each BA's estimated personal readiness based on the assigned individuals' personal characteristics (linear projections from Estimation Step 1), proportional BA composition for soldier grade in 5 categories, civilian education in 4 categories, individuals who have never deployed, former active component soldiers, fiscal year, SRC type and category, UPC size quintile, and percent female. Orphaned BAs are defined by text search excluding Engineering, Signal, Military Police, Medical, Intelligence, Chemical, and Supply companies. Combat arms are defined as Infantry (SRC 07, 67, 77), Armor (SRC 17), and Artillery (SRC 06), Maneuver Enhancement Brigade (SRC 37), and Air Artillery (SRC 44)

6. Conclusions

This research estimates the impact of T32 AGRs in the Army National Guard on the personal readiness of drilling soldiers located in the same approximately battalion-level unit (BA). We focus on MTOE units during “foundational readiness” periods, when individuals and units are not mobilized in preparation for deployment, deployed, or recently returned from deployment. Soldiers are considered “personally ready” if they are available to deploy in a given month.

Movement of troops between units over the period of analysis in a manner correlated with T32 AGR exposure levels and personal readiness outcomes confounds the unit-level relationship between personal readiness and T32 AGR staffing by introducing selection bias. Reorganizations and other common managerial practices also muddle the analytic environment. These complexities make it impossible to estimate the actual effect of T32 AGRs on personal readiness levels using only unit-level data. We therefore developed a multi-stage individual-level approach, using a nested fixed effects regression strategy to estimate the underlying human capital production function. We estimated the model using a man-month level data set of rich individual and unit characteristics, comprising monthly repeated observations of all ARNG members from 2001-2014 (43 million records). To our knowledge, this is the first study to quantitatively estimate the impact of T32 AGRs on the generation of foundational individual readiness at the individual level.

We find that same-unit MTOE T32 AGRs have a persistent, robust, positive effect on personal readiness levels. Quintile analysis reveals diminishing same-unit personal readiness returns to T32 AGR concentration as measured by the ratio of T32 AGRs to total soldiers within a battalion-level unit, as expected of any normal input to a production process. The main results imply that for average units in the first quintile of T32 AGR saturation, an increase of one percentage point in T32 AGR exposure increases the unit’s ratio of personally ready drilling soldiers by 8.4 percentage points after adjusting for individual and unit characteristics. Second quintile units experience an average marginal increase of 4.1 percentage points in the personally ready ratio following a one percentage point increase in T32 AGR exposures. This pattern of positive, decreasing returns continues through the fifth quintile, where a one percentage point increase in the unit’s T32 AGR ratio has no statistically significant marginal impact on the personal readiness of the unit’s drilling soldiers. This finding is unsurprising given that the fifth quintile contains the largest share of headquarters units, which are likely focused on performance metrics for units other than their own. (Recall that our methodology captures only same-unit personal readiness effects.) Results are also strengthened by the exclusion of units with extremely low headcounts and are robust within the subsets of combat arms units, and units that are not commonly supported by TDA troop commands.

Given the distribution of T32 AGRs and drilling soldiers as of September of 2014, our results imply that a proportional (by unit) cut of 3,000 T32 AGRs (20%) would reduce the count of personally ready drilling soldiers by approximately 16,000 persons (5.4% of force, 5.4 ready soldiers per marginal T32 AGR). Conversely, a targeted increase of 1,000 MTOE T32 AGRs in first quintile units and 500 MTOE T32 AGRs in second quintile units would increase the count of personally ready drilling soldiers by approximately 6,700 persons (2% of force, 4.5 ready soldiers per marginal T32 AGR). The marginal impact of the proportional cut is higher than the impact of the targeted addition to quintile 1 and 2 units because the distribution of units across quintiles as of September 2014 skews upward. Therefore, the targeted addition of T32 AGRs in the lowest quintiles of T32 AGR saturation affects a relatively small share of the September 2014 force.

Because we only assess the impact of T32 AGRs on personal readiness in their own BAs, our findings fail to capture any cross-unit returns that may exist. For example, headquarters-level T32 AGRs might influence personal readiness in subordinate units. We also consider only one of the many potential mechanisms by which T32 AGRs may impact readiness, using an approximate measure of cumulative T32 AGR influence at the individual level. For these reasons, our estimated coefficients should be interpreted as lower-bound estimates of the impact of T32 AGRs on readiness. While this work improves our understanding of the productivity outputs of T32 AGRs, determining optimal staffing levels would require a better understanding of both their costs and benefits in producing other types of readiness and facilitating non-readiness unit products. Nonetheless, these results represent a first step toward identifying an optimal level of T32 AGR staffing at approximately the battalion level.

Appendix A.
Complete Individual-Level Regression Results

Results from the Step 1 regressions are presented in Table A-1 below. Overall, the Step 1 covariates explain approximately 10% of the variation in personal readiness levels beyond that explained by individual idiosyncrasies (which are captured by individual-level fixed effects). Age impacts readiness in a non-linear manner, with the negative linear effect generally outweighing the positive coefficient on the squared term. For example, for a 30-year-old individual, the overall impact of age is to reduce the likelihood of personal readiness by 49%. Soldiers in all age groups are more likely to be ready than the reference group of enlisted individuals in ranks E5 through E9, with effects for officers notably larger than those for young enlisted personnel. Relative to the reference group of high school completers, those with a bachelor's degree or higher display systematically greater probability of readiness in a given month. As expected, indicators of poor health status or physical limitation are all strongly negatively correlated with readiness.

Table A-1. Complete Individual-Level Regression Results

Continuous Variables	
Age	-0.0469***
	(-88.495)
Age Squared	0.000615***
	(83.311)
Indicators for Rank, E5-E9 as reference	
E1-E4	0.0610***
	(51.538)
O1-O3	0.434***
	(91.909)
O4-O9	0.447***
	(77.751)
Warrant	0.294***
	(33.003)
Less than High School	0.00482**
	(2.717)
Some College	0.00172
	(1.590)
Bachelor's Degree	0.0230***
	(12.501)
Masters +	0.0283***
	(11.583)
>3 in any of PULHES	-0.487***
	(-251.665)
Minor Limitation	-0.111***
	(-63.058)

Table A-1. Complete Individual-Level Regression Results (continued)

Physical Limitation	-0.161***
	(-75.764)
Deployment Limitation	-0.207***
	(-43.647)
Admin	-0.0102***
	(-4.845)
Auxiliary	0.0149***
	(11.828)
Aviation	0.0276***
	(12.887)
Unknown	0.0172***
	(6.497)
Controls for:	
SRC2	X
SRC5	X
Fiscal year	X
Time to Deployment	X
R-squared	0.096
Observations	32,988,586

Notes: t statistics in parentheses, significance levels of * p <0.05, ** p<0.01, ***, p<0.001.
Regression excludes records of individuals which are in a mobilized or deployed period, <12 months after a mobilized and deployed period, IET training, and TDA

Appendix B.
Full Unit-Level Regression Results

Table B-1. Full Stage 2 Regression Results

Unit-Month Level Covariates	Full Population	Quintiles 1	2	3	4	5
Avg. Percent 6mo trailing T32 exposure	1.130***	8.435***	4.125***	2.732***	1.709***	-0.0703
	(7.268)	(14.627)	(6.049)	(4.661)	(5.012)	(-0.551)
Avg. Predicted Stage 1 Readiness	0.965***	0.951***	1.077***	1.066***	0.953***	0.778***
	(32.065)	(14.616)	(19.199)	(19.611)	(17.156)	(20.071)
Pnt. E5-E9	-0.262***	-0.293***	-0.246***	-0.246***	-0.124*	-0.0941*
	(-8.356)	(-6.177)	(-5.216)	(-5.191)	(-2.482)	(-2.261)
Pnt. W	-0.180**	-0.346**	-0.240*	-0.239*	-0.129	0.0202
	(-2.808)	(-3.142)	(-2.262)	(-2.080)	(-1.613)	(0.299)
Pnt. O1-O3	-0.451***	-0.426***	-0.389***	-0.525***	-0.458***	-0.225**
	(-7.131)	(-4.262)	(-4.281)	(-6.501)	(-6.132)	(-3.064)
Pnt. O4-O9	-0.617***	-0.424*	-0.569***	-0.550***	-0.425**	-0.210**
	(-5.090)	(-2.384)	(-4.259)	(-3.799)	(-3.291)	(-2.848)

Table B-1. Full Stage 2 Regression Results (continued)

Unit-Month Level Covariates	Full Population	Quintiles 1	2	3	4	5
Pnt. AC Converts	-0.0799	-0.0187	-0.0760	0.0588	0.0935	-0.105
	(-1.439)	(-0.256)	(-0.677)	(0.739)	(0.938)	(-0.872)
Pnt. in First Spell	-0.114***	-0.161***	-0.134***	-0.155***	-0.105***	-0.0676***
	(-8.797)	(-5.576)	(-6.323)	(-7.123)	(-5.661)	(-3.575)
Pnt. in Initial Entry Training	0.246***	0.354***	0.163***	0.142***	0.146***	0.0464
	(12.124)	(9.678)	(4.974)	(3.772)	(3.840)	(1.679)
Pnt. < 12 Months After Deploy	-0.0701***	0.0426*	-0.0436***	-0.0863***	-0.0799***	-0.0704***
	(-9.959)	(2.011)	(-3.620)	(-8.657)	(-9.176)	(-7.448)
Pnt. Female	-0.0352	0.0154	-0.0869	0.00455	-0.0682	-0.0282
	(-1.300)	(0.325)	(-1.941)	(0.096)	(-1.457)	(-0.848)
Pnt. with BA as Highest Degree	0.0816	0.0555	0.0428	0.233***	0.110	0.0405
	(1.678)	(0.517)	(0.513)	(3.405)	(1.555)	(0.894)
Pnt. with Masters + as Highest Degree	0.209**	0.241*	0.0786	0.208*	0.00114	0.112
	(2.724)	(1.970)	(0.643)	(2.568)	(0.011)	(1.675)
Pnt. with High School Diploma as Highest Degree	0.0551	0.0338	-0.0204	0.0559	0.0249	0.0775
	(1.809)	(0.502)	(-0.377)	(1.251)	(0.441)	(1.842)

Table B-1. Full Stage 2 Regression Results (continued)

Unit-Month Level Covariates	Full Population	Quintiles 1	2	3	4	5
Pnt. with Some College	0.00493	-0.112	-0.0544	0.00300	-0.0126	0.0685
	(0.157)	(-1.573)	(-1.016)	(0.074)	(-0.230)	(1.751)
Unit Size Quintile 1 (smallest)	-0.0374***	0.0219	-0.0179	-0.0133	-0.00904	-0.0171*
	(-5.397)	(1.405)	(-1.628)	(-1.285)	(-0.781)	(-2.255)
Unit Size Quintile 2	-0.00647	-0.00744	-0.000570	-0.00777	0.00505	0.00214
	(-1.736)	(-1.309)	(-0.114)	(-0.920)	(0.589)	(0.503)
Unit Size Quintile 4	0.00587	-0.0679*	0.0211	0.0232*	0.0130*	0.00148
	(1.103)	(-2.532)	(0.968)	(2.174)	(2.173)	(0.267)
Unit Size Quintile 5	0.0108	-0.0159	0.0249	0.0204	0.0214*	0.0152
	(1.332)	(-0.456)	(1.102)	(1.731)	(2.494)	(1.685)
Controls for Fiscal Year	Yes	Yes	Yes	Yes	Yes	Yes
R-squared	0.241	0.334	0.232	0.235	0.193	0.189
Observations ł	42,204,726	8,119,936	7,915,834	8,115,805	8,474,252	9,578,899

Notes: Statistically significant at or above the *** 0.1% level, ** 1% level, * 5% level; t-statistics in parentheses. Regressions include all units in the analysis set. ł - Observations reweighted to population size of units.

Appendix C.
Illustrations

Figures

Tables

Appendix D.
References

Brauner, Marygail K. and Glenn A. Gotz. "Manning Full-Time Positions in Support of the Selected Reserve." Santa Monica, CA: RAND Corporation, 1991. http://www.rand.org/pubs/reports/R4034.html, accessed June 2016.

Center for Army Analysis. "Full-Time Support and Readiness-Reserve Components (FAR-RC)." October 15, 2015.

Feickert, Andrew. "U.S. Army's Modular Redesign: Issues for Congress." (RL32476; May 5, 2006). U.S. Congressional Research Service. http://fpc.state.gov/documents/organization/67816.pdf, accessed June 2016.

Gilmore, J. Michael. "Issues That Affect the Readiness of the Army National Guard and Army Reserve. Testimony before the Commission on the National Guard and Reserves." Washington, D.C.: Congressional Budget Office. May 2007. https://www.cbo.gov/sites/default/files/110th-congress-2007-2008/reports/05-16-nationalguard.pdf, accessed June 2016.

Morrison, John E., John Metzko, and Charles Hawkins. "Planning and Preparing for Training in Reserve Component Units." Alexandria, VA: Institute for Defense Analyses, April 2002.

U.S. Army. "Standards of Medical Fitness." Department of the Army. AR 40-501. Washington, D.C.: Government Printing Office, 2007, edited 2011.

U.S. Code, Title 10 Sec. 101. "General military law." 2010 ed., https://goo.gl/5kyOfp, accessed June 2016.

U.S. Code, Title 10 Sec. 3013. "Secretary of the Army" https://www.gpo.gov/fdsys/pkg/USCODE-2015-title10/pdf/USCODE-2015-title10-subtitleB-partI-chap303-sec3013.pdf, accessed June 2016.

U.S. Code, Title 32 Sec. 328 and Sec. 709. "Active Guard and Reserve duty: governor's authority." 2011 ed., https://goo.gl/4xfgup, accessed June 2016.

Appendix E.
Abbreviations

AGR	Active Guard and Reserve
ARNG	Army National Guard
ARNG-HRM	ARNG Personnel Programs, Resources and Manpower Division
BA	Battalion Approximation
FTS	Full Time Staff (T32, MilTech, or T10)
MilTech	Military Technician
MOS	Military Occupational Specialty
MOSQ	Military Occupational Specialty Qualified
MRC	Medical Readiness Code
MTOE	Modified Table of Organization and Equipment
PULHES	Physical Capacity, Upper Extremities, Lower Extremities, Hearing, Eyes, and Psychiatric assessment indicators from the Military Physical Profile Serial System
SRC	Standard Requirement Code
SRC2	First two digits of SRC
SRC5	Fifth digit of SRC
T10	Title 10 Active Guard Member or Reservist
T32	Title 32 Active Guard Member or Reservist
TDA	Table of Distribution and Allowances
TTHS	Transient, Trainee, Holding, and Student
UIC	Unit Identification Code
UPC	Unit Processing Code (Unit Identification Code without Service Code)

REPORT DOCUMENTATION PAGE	*Form Approved OMB No. 0704-0188*

1. REPORT DATE (DD-MM-YYYY)	2. REPORT TYPE	3. DATES COVERED (From – To)
XX-09-2016	Final	

4. TITLE AND SUBTITLE *Assessing the Effect of Title 32 Active Guard and Reserves on Personal Readiness in the Army National Guard*	5a. CONTRACT NO. HQ0034-14-D-0001
	5b. GRANT NO.
	5c. PROGRAM ELEMENT NO(S).
6. AUTHOR(S) Julie Pechacek, Project Leader Allen Wang Ethan Novak	5d. PROJECT NO. DZ-6-3991
	5e. TASK NO.
	5f. WORK UNIT NO.
7. PERFORMING ORGANIZATION NAME(S) AND ADDRESS(ES) Institute for Defense Analyses Strategy, Forces and Resources Division 4850 Mark Center Drive Alexandria, VA 22311-1882	8. PERFORMING ORGANIZATION REPORT NO. IDA Paper P-8123 Log: H 16-000962
9. SPONSORING / MONITORING AGENCY NAME(S) AND ADDRESS(ES) National Guard Bureau 111 S George Mason Dr. Arlington, VA 22204	10. SPONSOR'S / MONITOR'S ACRONYM(S) ARNG
	11. SPONSOR'S / MONITOR'S REPORT NO(S).

12. DISTRIBUTION / AVAILABILITY STATEMENT

Approved for public release; distribution is unlimited.

13. SUPPLEMENTARY NOTES

14. ABSTRACT

We estimate the impact of Title 32 Active Guard Reserve soldiers (T32 AGRs) in the Army National Guard on the deployment availability of drilling soldiers located in the same battalion. We focus on Modification Table of Organization and Equipment (MTOE) units during periods when individuals and units are not mobilized in preparation for deployment, deployed, or recently returned from deployment. The common practice of moving troops between units correlates with T32 AGR exposure levels and personal readiness outcomes, and thus introduces selection bias at the unit level. We therefore develop an individual-level approach using 43 million monthly observations of ARNG members in MTOE units from 2001-2014. We calculate each individual's cumulative T32 AGR exposure separately, and track investment levels as individuals move between units. We then estimate the impact of T32 AGR exposure on personal readiness levels, holding constant a wide variety of personal and unit characteristics. To our knowledge, this is the first study to quantitatively estimate the impact of T32 AGRs on personal readiness at the individual level. We find that same unit MTOE T32 AGRs have a persistent, robust, positive effect on personal readiness levels that diminishes as the ratio of T32 AGRs to total unit soldiers increases.

15. SUBJECT TERMS

Army National Guard; Full-Time Support; Full-Time Personnel; Title 32 AGRs; T32 AGRs; personal readiness; individual readiness; deployability; human capital production; productivity; FTS; ARNG

16. SECURITY CLASSIFICATION OF:			17. LIMITATION OF ABSTRACT	18. NO. OF PAGES	19a. NAME OF RESPONSIBLE PERSON Major Kelly Chestnut
a. REPORT	b. ABSTRACT	c. THIS PAGE			19b. TELEPHONE NUMBER (Include Area Code) (703) 601-6736
U	U	U	Same as Report	74	

This page is intentionally blank.